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NEW YORK • LONDON

WORLD PETROLEUM

Financial Results of 1934 Indicate Noteworthy Improvement in U. S. and Delayed Recovery in Great Britain • Afghanistan Concession? Geology and Economic Significance of Oklahoma City Abstracts of World's Petroleum Literature

JANUARY • 1935

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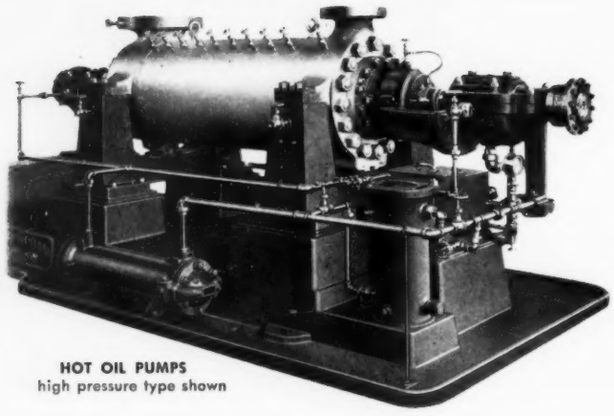

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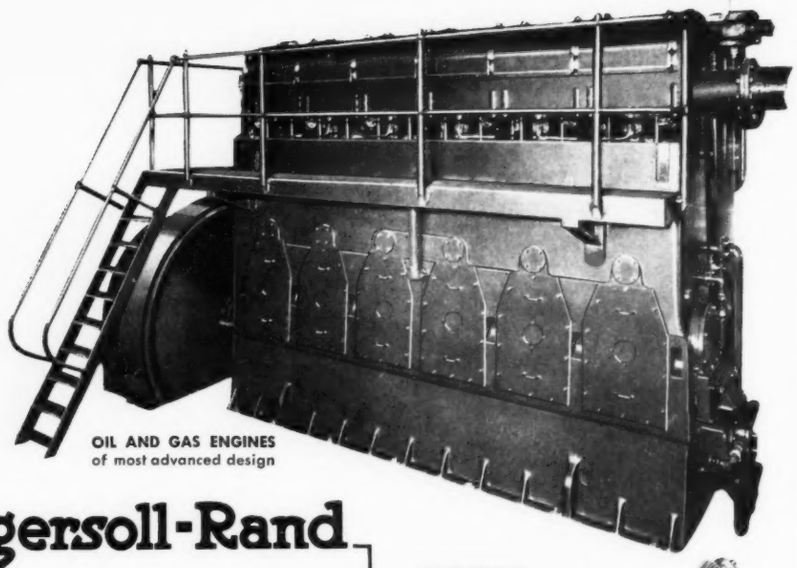
high pressure type shown



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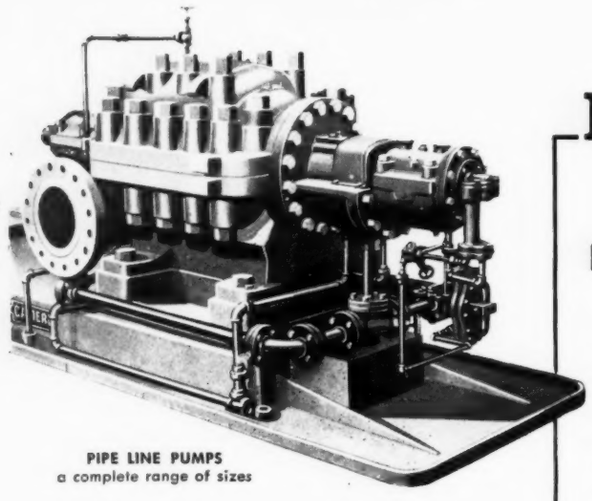

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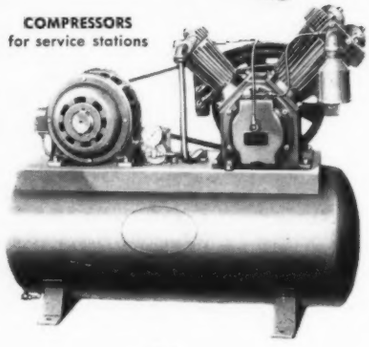

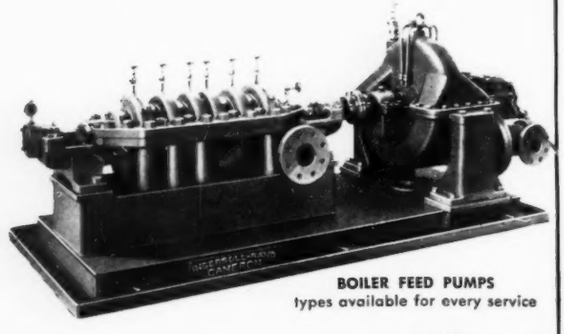

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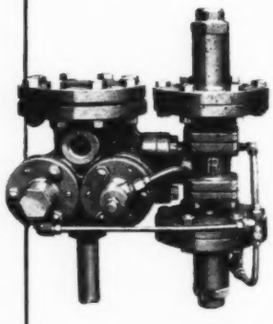

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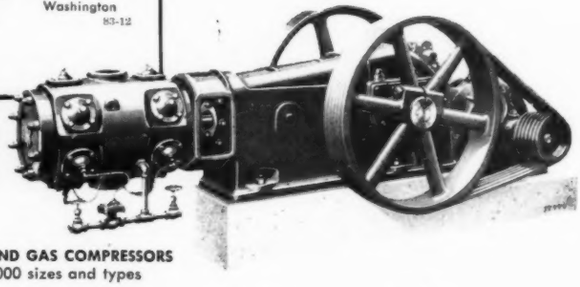

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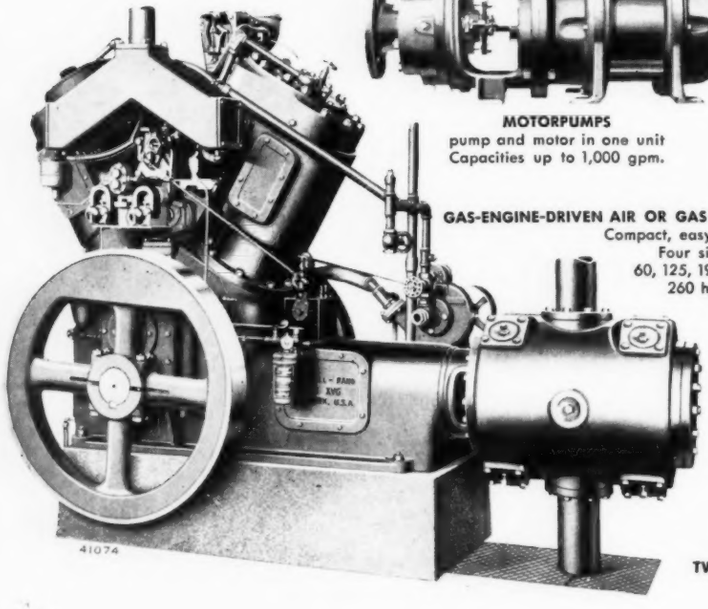

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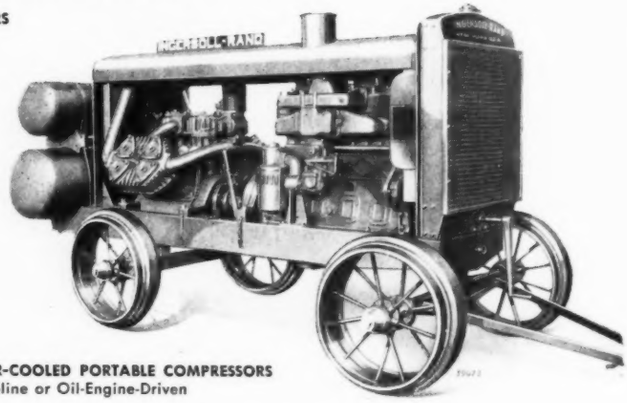

TWO-STAGE AIR-COOLED PORTABLE COMPRESSORS
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JANUARY
1935

WORLD PETROLEUM

VOLUME VI — **Editor, E. W. Mayo** — NUMBER 1

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Published Monthly by

RUSSELL PALMER

56 West 45th Street, New York, U. S. A.

Cable Address, Ruspam, New York and London

Advertising Manager, S. J. Gallay

Executive-Editor, T. Orchard Lisle

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CALIFORNIA OFFICE: Bendix Bldg., Los Angeles

London: 3 Savoy Place, Victoria Embankment, W. C. 2

Subscriptions

ANNUAL subscription to WORLD PETROLEUM is offered at the flat rate of five dollars (U. S.) postpaid to any country in the International Postal Union, except in Canada where a special tax compels the publisher to charge $5.60.

For the convenience of subscribers the publisher will accept payment in any of the following currencies at the fixed rate shown below:

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Remittances or drafts to the order of the Publisher, WORLD PETROLEUM, payable in New York and London.

Subscriber's name and address should be in Roman capitals on the subscription order.

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The price of a single copy is 55 cents in Canada, 2 shillings in other countries of the British Commonwealth and the equivalent of 50 cents (U. S.) elsewhere.

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PETROLEUM

Majors and Independents

As a convenient means of distinguishing the large integrated oil companies or those whose operations are international in extent from those whose business is of narrower scope, it has become customary to classify these groups as majors and independents or, as in England, the combine companies and the independents. The rough assumption is often made that the interests of these two classes are antagonistic. Actually, of course, such is not the case, nor is it the fact that the two groups are always to be found in opposing camps.

In the operations of the American industry under the petroleum code and in the efforts at the regulation of marketing practices by voluntary agreement, the great majority of independent companies have steadily and consistently supported the constructive policies incorporated in these measures. In all kinds of business there are some few men who are extremists in their views as to their individual rights and in almost all industries there is a fringe of piratical operators whose activities are distinctly against the general welfare. But it is unfair to include these outlaws and mavericks in the same category with self-respecting independents.

Similarly in the United Kingdom the small but sturdy group of well-established independent dealers disavow as vigorously as do the combine companies the activities of those fly-by-night operators who spring up when conditions are favorable, grab such business as can be readily influenced by price cutting and disappear when the going gets hard with no sense of responsibility to the customers whom they have promised to serve.

▼

Costly Trade Favoritism

Sound reason can be found in Britain's abundant coal deposits and paucity of petroleum resources for a desire on the part of the governing authorities to determine the feasibility of producing motor fuel from coal. Gradual depletion of the world's oilfields with advancing prices in time may make British and other coal mines an important source of supply of liquid fuel. Very thorough tests of the means available for producing oil from coal, shale, lignite or other potential sources have shown, however, that for the present and probably for a long time to come none of these methods can compete commercially with the flowing well or even with the well that must be pumped.

Under these circumstances the wholesale subsidizing of the less economical means of production to displace the more economical not only lacks justification but injuriously affects many industries aside from those directly concerned. A great part of the *malaise* from which industry and trade are suffering in many parts of the world results from the handicaps imposed by governments in the attempt to help one industry at the expense of another.

In Great Britain the adoption of a general act guaranteeing to motor fuel produced from native coal a preference of not less than 4d. (8 cents) a gallon for a period of nine years is bringing forward a large number of companies anxious to participate in this handsome bounty. So far as has yet appeared none of these projects could hope to exist without preferential treatment. If a considerable number of such undertakings dependent on the public treasury are brought into being all past experience will be belied if the voice of vested interests does not prove too strong for the government to resist at the end of nine years with the result that another permanent burden will be added to the taxpayer's load.

So far as concerns the influence of the British act in relieving unemployment in the coalfields, a careful study indicates that it would be cheaper for the government to support in luxury and idleness all the miners who will find work through this legislation than to give them employment by this means. The real harm of measures such as these, however, falls upon the industries that are deprived of cheap fuels or cheap materials and that consequently find their operations restricted in competition with others not so handicapped. Unless early action is taken to restrict its application it is likely to cost the British public far more than it can possibly return.

▼

Technical Abstracts

Starting with this issue a new feature of the utmost importance to oil men will be included in the pages of World Petroleum each month. This feature will consist of brief but clarifying summaries of all the more important articles on oil published throughout the world. By means of the technical abstracts published in this Journal readers will be able to keep abreast of modern engineering theory in every country of the world. This feature should be of great service to World Petroleum readers, and the editors will appreciate any suggestions from readers for improving or extending the scope of the abstracts.

Counting the Profits of a Good Oil Year

Estimates of full 1934 Earnings Indicate the Excellent Progress the Industry Has Made Toward Recovery.

By John A. Moffitt

NINETEEN thirty-four was a good oil year. Early estimates show production of crude petroleum throughout the world close to the peak year of 1929 and consumption not far below the highest on record. Output gains in Persia and Venezuela were particularly striking while in the United States consumption rose faster than production, creating a better balance between supply and demand. The petroleum industry, still wrestling with its serious problems, has not yet returned to normal. But during the past 12 months it has made tremendous progress on the road to recovery.

Financially, too, 1934 was an improvement over the year preceding. The increases in consumption combined with the higher average prices prevailing over the year to eliminate most of the deficits that have cluttered earnings statements. Little red ink will be found in the annual reports of the major units. Instead of failing fully to cover interest or preferred dividends, most companies now show substantial amounts available for dividends on the common stock. And that is a record that can be equalled by few industries at this stage of the business cycle.

Unfortunately all divisions of the industry in the United States did not make equal progress. The new oil deal handed far more aces to the producers, gave relatively poor hands to refiners and marketers. Crude prices, which had been pulled from depression depths during the late summer of 1933, were well maintained throughout 1934, despite the constant threat of illegally produced crude to the entire price structure. The increase in crude run to stills together with these higher prices served to more than double the gross value of all oil consumed during the first half of the year, and even raised the value somewhat during the last half, as compared to the corresponding 1933 periods. The importance of this increase may be easily seen in the earnings reports of the producing companies.

Amerada Corp., for example, which aside from its output of casinghead gasoline is solely a producer of crude, had a deficit of 78¢ per share in the first two quarters of 1933. It had a profit of $1.67 a share during the same 1934 period. Ohio Oil Co., another leading crude producer, turned an earlier loss of 73¢ a share into a profit of 26¢ a share during the first half of the year just past. In both cases returns for the third quarter showed above the third quarter of 1933 and equally satisfactory results are anticipated for the final quarter.

Gasoline prices advanced faster and further than did those of crude during the 1933 run up. But the gains could not be held. Coupled with the steady upward march of crude, this decline operated to squeeze the refiners' margin throughout most of 1934. The squeeze was not so severe as to bring that margin below the profit level. It left margin enough to keep gross earnings for the first half of 1934 above those for the same 1933 period, margin enough to turn most of the earlier red ink figures into black. And although the margin was less favorable during the last half of the year, the gains in the first half were more than sufficient to assure a larger total return for the full twelve months.

The marketing picture was clouded by an outbreak of retail gasoline price wars. Brought on largely by the failure to curtail "hot" oil, these wars caused heavy losses in some territories while leaving others practically unaffected. And, at the same time, some companies were profiting more from the larger retail purchases of motor fuel than were others. Price was only one of the weapons used in the fight to gain sales but, fortunately for the oil companies, advertising and performance claims proved less costly than price wars.

The net effect of these changes was to leave the earnings of refining and marketing organizations just slightly above the 1933 levels. Companies such as Atlantic Refining Co. and Standard Oil Co. (Ohio) undoubtedly did better than in the year preceding but their gains were small compared to similar sized concerns which produced a greater proportion of their own crude consumption.

Lying behind the basic figures of sales and prices are a number of less important factors that have affected the 1934 earnings of American companies. Proration, in some instances, forced well integrated units into the market to cover their needs for crude. In other cases the forced reduction in output has permitted a lowering of charges for depletion and depreciation that appreciably raised the amount available for the common shares. And in practically every case the new Revenue Act, which specifically limits the deductions the income tax authorities will allow for depreciation and depletion, will bring about some alteration in these charges. Should this law work to reduce the large reserves regularly set aside by the oil companies, and that was the intent of the framers of the bill, reported earnings, and incidentally federal taxes will be higher. But the shareholder will not find his position improved by these higher reported earnings for the same funds will not be available later for the replacement of his depreciated and depleted property.

Much more solid are the income gains arising from recent refinancing operations. Since 1930 the oil companies have cut more than $200,000,000 from their funded debt and, in addition, have taken advantage of the low interest rates now prevailing to reduce the charges on much that remains outstanding. These savings, more important in 1934 than in 1933, will become even larger when their full effect is felt during the coming year.

Typical of the many recent financial changes was the calling by Socony-Vacuum Oil Co. of two bond issues of its subsidiaries totaling $28,000,000. All but $1,000,000 of this amount, which the company will take from its treasury, will be obtained from bank loans at substantially lower interest rates. Similarly, Standard Oil Co. (N. J.) has called $90,000,000 of its debenture 5s, the entire issue, and intends to raise this amount partly by bank loans, partly from a new issue of debentures and partly with cash from its treasury. And Sun Oil Co. has retired some $7,500,000 of its 5½s and issued in their stead $6,500,000 3¾ percent debentures with a resultant saving to the common stockholders of about 11 cents a share.

	Earnings Per Common Share									Net Earnings			
	1934												
	Estimated	Reported											
	Full Year	3rd qu.	2nd qu.	1st qu.	1933	1932	1931	1930	1929	1933	1932	1931	1930
Amerda Corp.	$2.75	$.46	$1.10	$.57	$ .50	$1.48	$D2.22	$4.64	$3.11	308,444	1,147,207	D1,701,648	3,961,476
Anglo Persian Oil Co., Ltd.	.45[5]	...	...	...	.40[6]	.27[6]	.18[5]	.83[6]	.81	£2,141,794	£1,805,345	1,516,773	3,098,361
Atlantic Ref. Co.	2.65	.90	.89	.23	2.46	1.45	.19	1.02	6.20	6,556,377	3,918,021	513,750	2,742,683
Barnsdall Corp.	nil	D.25	.02	.05	D.36	D.37	D1.45	2.27	3.19	D1,942,635	D847,072	D3,268,637	5,130,891
British Cont. Oilfields, Ltd.	nil	...	...	...	D.12	D.23	D.86	....	....	$820,425[7]	672,234	D189,689	167,791[8]
Burmah Oil Co., Ltd.	.90[6]	...	...	...	1.05[6]	.76[6]	.69[6]	1.35[6]	2.15	£1,444,648	1,052,760	957,620	1,856,013
Colon Oil Corp.	D.70	...	...	...	D.50	D.64	D.37	D.58	....	$D1,100,521	D1,408,359	D822,336	D1,289,944[7]
Consolidated Oil Corp.	.30	not reported			D.05	.02	D1.63	1.77	2.82	133,580	1,108,046[13]	22,010,173[14]	12,026,424
Continental Oil Co.	1.40	.43	.25	.25	.18	D.30	D2.54	.05	1.90	872,692	1,144,133	D12,045,575[7]	225,598
Creole Petroleum Corp.	.81	...	...	...	.59	.30	D.65	.26	.41	$4,106,099	2,075,404	D4,510,466	1,665,045
Gulf Oil Corp. of Pa.	3.60	not reported			D2.51	.60	D5.23	2.35	9.83	D11,386,387	2,743,492	D23,658,865	10,649,334
Houston Oil Co. of Texas	nil	D.18	.05	.04	D.93	D1.31	D.81	1.02[1]	4.78	D487,178	D901,648	D356,484	1,655,337
Imperial Oil, Ltd.	.60	...	...	...	.53	.55	.68	.72	.99	$14,101,561[7]	14,713,237	18,226,895	19,020,360
Maracaibo Oil Exp. Corp.	nil	...	...	...	D.01	D1.87	D1.38	....	....	$D3,290	D603,640	D446,509	.....
Mexican Petroleum Co., Ltd.	nil	...	...	...	D10.71	D13.98	D15.51	3.09	11.13	$D3,953,219	D5,434,002	D6,131,724	2,374,561
Mid-Continent Pet. Corp.	.90	.20	.43	.16	D.95	D1.12	D2.67	.80	4.10	D1,766,438	D2,081,900	D4,962,411	1,493,057
Ohio Oil Co.	.55	.12	.17	.09	D.53	.58	D1.92	1.21[2]	5.14	D130,016	7,242,981	D9,334,136	10,630,015
Phillips Pet. Co.	1.50	.41	.43	.17	.36	.19	D1.34	.71	5.19	1,500,695	775,766	D5,576,409	3,040,630
Pure Oil Co.	.05	not reported			D.53	D.64	D.52	.18	1.52	455,203	109,316	470,178[15]	2,617,748[15]
Royal Dutch Co.	no basis for estimate				.81[11]	.75	.74	2.39	3.33	30,546,306	28,303,692	27,916,648	90,836,415
Shell Union Oil Corp.	.20	.07	D.11	D.05	D.49	D.12	D2.23	D.56	1.26	D4,240,965	660,076	D27,008,310	D5,095,574
Socony-Vacuum Corp.	1.20	not reported			.71	.17	D.13	.92[3]	2.32[3]	22,545,461	5,320,282	D4,169,248	.....
Stand. Oil Co. (Cal.)	1.15	.45	.31	.25	.58	1.07	1.11	2.88	3.63	7,540,903	13,994,992	14,539,593	37,675,301
Stand. Oil Co. (Ind.)	1.25	not reported			1.12	1.04	1.04	2.73	4.66	17,674,351	16,558,282	17,596,396	46,371,438
Stand. Oil Co. (N. J.)	1.60	not reported			.97	.01	.34	1.65	4.75	25,084,801	282,865	8,704,758	42,150,663
Trinidad Leaseholds, Ltd.	10.63[5]	...	...	...	.75[5]	.76[5]	D.02[5]	.39[5]	1.19[5]	£196,750[16]	£197,793[16]	D£6,721[16]	102,597[16]
Humble Oil & Ref. Co.	3.15	not reported			2.32[4]	5.01	.93	6.08	10.94	20,847,818	14,896,613	2,765,092	18,083,491
Stand. Oil Co. (Ohio)	nil	not reported			D1.89	D2.41	2.34	5.56	6.62	D823,357	D1,206,361	2,359,173	3,724,326
Sun Oil Co.	4.50	...	(6 mos.) 2.03		3.67	2.26	1.64	4.69	5.62	6,971,844	4,198,046	3,107,147	7,745,484
Texas Corp.	1.40	not reported			D.05	D.22	D1.01	1.53	4.91	D491,004	D2,161,841	D9,954,478	15,073,303
Tide Water Ass. Oil Co.	.50	.17	.06	.08	.61	.12	D1.75	.76	1.73	7,265,300	4,718,694	D5,818,671	8,750,914
Union Oil Co. of Cal.	.55	.32	D.05	.11	.45	.73	D.95	2.19	3.56	1,954,279	3,211,084	D4,155,150	9,604,997
Venezuelan Petroleum Co.	nil	...	...	...	D.01	D.02	.05	.15	.19	$D19,366	D50,882	104,512	291,129

[1] Stock split 4 for 1—1930.
[2] Stock split 2 for 1—1930.
[3] Standard Oil (N. Y.) only.
[4] Stock split 3 for 1—1933.
[5] Dollars per share on basis 1£=$5.00.
[7] 11 months to December 31, 1930.
[8] 17 months to December 31, 1930.
[9] Year to July 31, 1929

Oil Companies' Financial Record

	Depreciation and Depletion					Net Working Capital As of December 31						
1929	1933	1932	1931	1930	1929	1933	1932	1931	1930	1929	1933	1932
2,758,900	1,880,759[16]	1,853,401[16]	2,070,551[16]	4,217,494[16]	4,241,663[16]	4,942,424	7,328,270	6,762,882	10,081,790	7,877,565	.....	.....
3,043,047	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	£4,850,000	£5,045,00
17,332,417	10,176,940[17]	9,987,895[17]	11,286,694[17]	10,844,127[17]	10,153,852	40,015,137	34,945,032	35,285,503	45,347,796	54,655,991	14,046,793	14,070,79
7,205,162	2,121,365[18]	2,169,990[18]	3,745,352	4,234,596	4,436,473	3,760,360	2,915,649	3,692,338	5,120,482	8,214,262	.....	.....
1,205,574[9]	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2,767,461	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	£4,000,000	£4,000,00
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	$10,000,000	10,000,00
16,599,037	18,684,281	17,448,018	26,078,876	22,541,605	20,506,111	92,983,006	101,923,567	119,056,353	63,637,054[24]	43,260,860[21]	51,159,800	57,719,70
9,028,661	4,731,972	9,355,580	11,171,729	11,294,061	12,028,313	29,628,797	27,277,386	23,422,822	37,590,225	51,943,896	7,450,000	8,726,00
2,434,189	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
44,524,796	32,609,405	34,848,692	37,886,589	36,299,315	44,066,149	90,174,574	96,748,097	90,285,852	113,210,751	117,031,972	102,462,863	110,463,19
1,731,469	1,608,636	1,634,348	1,626,501	2,066,112	2,351,811	922,870	380,375	927,725	1,990,082	1,557,661	9,890,000	10,490,00
26,350,309	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
6,051,518	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
7,612,696	3,818,819	3,521,844	3,942,915	4,812,259	5,877,438	14,823,082	14,034,086	14,979,311	17,996,318	21,120,562	.....	.....
12,347,649	6,731,260	5,818,087	7,062,455	5,920,378	3,989,143	32,438,578	27,942,773	26,730,636	38,093,212	38,011,770	.....	.....
13,212,592	16,522,029	15,549,733	16,542,351	13,066,004	7,947,998	19,652,148	13,579,709	5,910,545	14,058,327	19,208,894	28,128,000	31,326,50
6,539,531[15]	7,108,120	6,591,176	5,648,299	5,708,419	9,690,068	12,804,584	12,866,310	14,465,130	16,261,106	27,395,540	30,500,000	32,500,00
126,471,392	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	F100,007,905	100,011,65
17,573,249	24,101,694	24,719,936	31,740,112	31,784,266	50,478,787[3]	56,784,051	59,651,205	70,281,199	73,469,523	105,005,136	79,636,500	91,141,50
.....	36,747,989[19]	38,763,437[19]	47,243,401[19]	38,833,587[19 3]	41,836,522[19 3]	208,663,144	238,259,829	258,102,458	200,299,809[3]	179,559,322[3]	82,458,500	86,552,50
46,633,490	17,143,177[20]	17,341,913[20]	18,023,323[20]	19,330,007[20]	21,089,201	85,290,291	80,711,983	80,866,335	93,707,447	102,240,796	.....	.....
78,499,754	29,152,991[21]	34,177,964[21]	49,463,146[21]	54,642,760[21]	not stated	192,298,852	203,452,389	214,897,729	216,495,360	143,384,951	125,000	31,905,50
120,912,794	112,006,572[22]	111,334,473[22]	109,823,976[22]	84,221,403[22]	79,543,059[22]	404,177,197	447,151,246	585,238,363	561,892,797	613,078,798	179,398,236	207,245,00
313,167[10]	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
32,535,080	15,736,536[12]	19,339,395[22]	18,125,427[22]	22,022,421[22]	21,933,720[22]	46,952,934	45,123,590	66,295,168	79,992,770	70,838,027	18,950,000	18,950,00
4,202,384	2,621,679[23]	2,955,308[23]	3,255,919[23]	2,426,408 [23]	1,845,735[23]	10,600,970	10,468,981	11,383,276	12,844,650	10,569,003	.....	.....
8,242,492	6,277,921[22]	5,957,318[22]	6,227,364[22]	6,676,907[22]	5,465,872[22]	18,084,678	17,193,195	16,088,390	14,705,077	13,695,250	10,541,000	11,864,00
48,318,072	33,004,255[22]	34,493,342[22]	38,520,433[22]	36,203,053[25]	31,928,218[23]	126,073,698	133,426,319	155,486,505	197,693,509	232,133,942	100,525,000	107,400,00
14,000,689	13,185,100	12,218,859	13,663,011	12,500,924	12,522,082	46,197,023	37,765,929	43,313,116	57,089,432	51,545,350	5,717,000	8,384,00
15,019,636	6,665,512[16]	6,917,664[16]	7,010,804[16]	9,145,368[16]	14,813,953[16]	42,640,151	45,739,876	47,675,448	61,089,549	58,293,742	26,687,100	31,609,14
371,630	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

[9] 13 months ended Jan. 31, 1932.
[10] Years ended June 30th.
[11] New York shares.
[12] Florins.
[13] 11 months ended Dec. 31, 1932.
[14] Fiscal year ended March 31 of following year.
[15] Including drilling expenses.
[16] No depletion.
[17] Including lease amortization.
[18] Including development costs.
[19] Including amortization.
[20] Including amortization.
[21] Including lease amortization.

Funded Debt				Cash Dividends						Price High-Low					
				Current Annual						To Dec. 1					
1932	1931	1930	1929	Rate	1933	1932	1931	1930	1929	1934	1933	1932	1931	1930	1929
.....	.....	.....	.....	$2.00	$2.00	$2.00	$2.00	$2.00	$2.00	55⅝–39	47⅝–18½	22¾–12½	23 –11¼	31½–16½	42⅝–17½
£5,045,000	5,240,100	5,435,000	5,304,500	...	7½%	7½%	5%	15%	20%	54s 4½d–41s 10½d	32½–12⅜	21⅞– 8⅝	23⅝– 8⅝	51⅜–16⅝	77⅞–30
14,070,793	14,594,759	14,158,759	14,038,759	1.00	1.00	1.00	1.00	2.00	2.00	35¼–21½					
.....	.....	65,377	118,902	...	...	...	.50	2.00	2.25	10 – 5⅞	11 – 3	7 – 3⅜	14½– 4	34 – 5⅝	49⅛–20
.....	.....	.....	.....	...	...	...	...	...	...	5s 7½d– 3s 6d	.....	.....	.....	.....	.....
£4,000,000	4,000,000	4,000,000	4,000,000	...	22½%	20%	17½%	22½%	30%	11s 3 d–7s 7½d	.....	.....	.....	.....	.....
10,000,000	10,000,000	10,000,000	10,000,000	...	...	...	...	...	...	.....	.....	.....	.....	.....	.....
57,719,700	61,866,700	65,595,000	82,167,000	.42[25]	...	...	.50	2.00	2.25	14¼– 7¼	15¾– 5	9 – 4	15⅞–4⅛	32 – 9¾	45 –21
8,726,000	9,955,000	18,431,000	32,111,000	.50[25]	...	...	...	...	...	22¾–15¾	19⅝– 4⅞	9⅜– 3⅝	12 –5	30½– 7¾	47⅛–18
.....	.....	.....	.....	...	...	...	...	...	...	.....	.....	.....	.....	.....	.....
110,463,195	125,559,391	125,904,000	65,414,000	...	...	..	1.50	1.50	1.50	76¾–49¾	62 –24	44¾–23	75½–25¾	166⅞–58½	209 –115
10,490,000	11,090,000	11,694,000	7,275,000	...	...	...	...	...	...	29¾–12½	7⅜– 1⅞	5⅜– 1⅝	14⅛– 3	11¾– 6⅝	109 –26
.....	.....	.....	.....	...	...	...	...	...	...	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	...	...	...	...	...	...	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	...	...	...	...	...	...	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.50[25]	...	...	.50	2.00	2.00	14¾– 9⅛	16– 3¾	8⅞– 3¾	16¾– 5	33 –11	39⅞–22⅛
.....	.....	7,491,977	.....	.45[25]	...	.50	.25	3.00[26]	2.75	15⅞– 8½	17⅝– 4¾	11 – 5	19½– 5⅛	32 –16[27]	79⅞–64½[27]
31,326,500	34,171,500	38,418,591	36,818,071	1.00	...	...	.50	2.00	2.00	20¾–13⅜	8¾– 4¾	8⅛– 2	16⅝– 4	44¾–11½	47 –24¼
32,500,000	34,500,000	36,500,000	38,000,000	...	...	...	...	...	1.125	14⅞– 6¼	15⅝– 2½	6½– 2⅞	11⅞– 3¼	27¼– 7⅝	30¾–20
100,011,650	100,103,599	128,500,000	.....	1.35NY	1.075	.805	2.2789	3.2165	3.209	.....	.....	.....	.....	.....	.....
91,141,500	117,440,500	125,501,000	126,334,500	...	...	...	...	.70	1.40	11½– 6	11⅝– 4	8¾– 2½	10¼– 2½	25½– 5¼	31¾–19
86,552,500	995,427,843	98,321,191[3]	98,918,661[3]	.60	.35	.75	.65	1.60[3]	1.60[3]	19⅞–12½	17 – 6	12¼– 5¼	26 – 8⅜	40⅜–19¾[3]	41⅛–31¾[3]
.....	.....	.....	.....	1.00	1.25	2.00	2.25	2.50	2.50	42⅞–26½	45 –19½	31⅞–15⅛	51¾–23⅛	75 –42¼	81⅞–51½
31,905,500	47,611,500	57,575,500	.....	1.00	1.00	1.00	1.50	2.50	3.25	32¾–23¼	34 –17	25⅛–13⅛	38⅛–13½	59⅞–30	63 –45
207,245,001	173,442,017	169,014,083	170,132,833	1.25	1.25	2.00	2.00	2.00	1.875	50⅛–39¼	47½–22¾	37⅜–19⅞	52½–26	84⅞–43½	83 –48
.....	.....	.....	.....	12½%	15%	12½%	5%	7½%	30%	.....	.....	.....	.....	.....	.....
18,950,000	42,944,000	43,801,000	44,618,000	1.00	2.00	2.00	2.50	2.00	2.00	46⅜–33¼	103¼–40⅛	54 –35⅞	72 –44¼	119 –57¼	128 –72
.....	.....	.....	.....	...	...	2.00	2.50	2.50	2.50	28½–12¼	41–15½	30⅛–15	62½–23	108½–43¼	129 –60
11,864,000	12,131,000	8,398,000	8,665,000	1.00	1.00	1.00	1.00	1.00	1.00	74¼–51½	59 –35	39⅞–24¾	45¼–26¾	70 –39	86⅜–55
107,400,000	115,000,000	116,000,000	118,135,000	1.00	1.00	1.25	2.00	3.00	3.00	29⅜–19¾	30⅛–10¾	18¼– 9¼	35⅞– 9⅞	60½–28¼	71⅞–50
8,384,000	11,140,000	13,859,000	16,541,000	...	...	...	...	...	...	14⅜– 8	11¾– 3⅛	5⅝– 2	9 – 2⅛	17¾– 5⅞	23½–10
31,609,144	32,546,500	34,546,500	19,544,500	1.00	1.00	1.20	2.00	2.00	2.00	20½–11½	23⅜– 8½	15⅛– 7¾	26 –11	49⅞–20⅛	55¾–42⅛
.....	.....	.....	.....	...	...	...	...	...	...	.....	.....	.....	.....	.....	.....

ement costs.
ation.
mortisation.

[22] Including amortisation and retirement.
[23] Includes depreciation only.
[24] Sinclair Consolidated Oil Co. only.
[25] Paid to December 1.
[26] $2.00 paid on old shares.
[27] Old Shares.

UNIV. OF MICH.

Practically every other major oil company has made some reduction in the amount of its outstanding funded debt, many have also lowered their bank loans and a few have retired large blocks of preferred stock.

In general, therefore, all these factors, higher prices, larger consumption, lower depreciation and depletion reserves and lower interest charges, have worked to lift the earnings per share that will be shown by the domestic oil companies in their 1934 returns. In general, too, the increased world consumption and the slightly better level of world prices have served to raise the earnings of oil companies incorporated outside of the United States. These organizations have profited to a smaller extent through the reduction in interest rates mainly because they have so little funded debt. They have gone in more for preference shares than for debentures and the stock is often more difficult to retire. And it is doubtful if many of these foreign companies will greatly reduce their charges for depreciation and depletion.

The common European practice of setting up hidden reserves that never appear in the balance sheet creates something of an enigma to American analysts. European industrial concerns frequently dip into earnings to keep these reserves at a high level and often pay unrevealed losses out of these accounts. It is also common practice for companies operating in new oil fields to make unpredictable and seemingly excessive charges for exploration, drilling and similar costs. Money taken from current income is freely plowed back into the property. Thus the reports of organizations outside the United States, while in perfect accord with correct accounting practices abroad, are on a little different basis from those within the United States and, in the absence of interim statements, much more difficult to estimate.

But known production in the various oil fields and known prices do make possible an approximation of the earnings of most of the international oil companies within a fairly liberal margin of error. Only in cases, such as Royal Dutch-Shell group, where income is derived largely from the dividends of subsidiaries and where these dividends do not vary immediately with changes in the earnings of the underlying companies, it is impossible to find some basis of estimate.

The past year also brought a little more cheer to those companies engaged in supplying the oil industry with its needed equipment. The unsettled conditions that existed during the preceding three years, when the great East Texas field was flush and crude could usually be purchased below the cost of production, hardly warranted large expenditures for the bringing in of new wells. But with federal control and the greater stability of prices that became evident late in 1933, the oil companies began to add to the geological crews in the field, began to step up the amount of drilling. These endeavors to add to underground reserves found immediate reflection in the activities of the makers of drilling equipment of all kinds. Profits soon replaced losses and, for the first time since 1930, most of these companies had earnings available for common dividends.

The market for refinery equipment, too, was improved during the past year by the better outlook for the industry and by the development of new processes for the production of motor fuel and lubricants. Unfilled orders of most of the makers of this type of equipment were largely increased. But the time required to turn these orders into profits is a little too long to have had their greatest effect on 1934 earnings. Their influence will be felt more fully during the current year.

The market for service station equipment, on the other hand, remained at a low ebb throughout the past twelve months. Retail marketing has been called the most overbuilt branch of an overbuilt industry and the oil companies do not seem anxious to add to their investments in this field. A number of the concerns supplying gasoline pumps and similar equipment are undergoing reorganization presumably to enable them to operate profitably under these new conditions.

With a good oil year behind them, the world's major units are looking forward to an even better year in 1935. The international companies expect a further development of their respective areas and the American companies are sanguine of a more thorough checking of hot oil, a betterment of refinery prices and an elimination of retail price wars. If these things can be achieved without resort to complete federal control, the way will be cleared for a complete recovery and earnings should approach their former normal level.

British Companies Dependent on America

ANY ATTEMPT to assess the profits of British oil companies must take account of the cardinal consideration that Britain is a consumer of petroleum products without being a producer. British oil undertakings produce abroad, and sell both in Britain itself and in overseas markets, and their financial experience during 1934 must have been subject to widely varying influences such as the trend of tax and oil legislation in the countries where they produce, apart from price changes in countries where they dispose of their products.

It is obvious therefore that no hard and fast rule can be applied in an estimate of financial results of the principal British oil concerns.

Official views and dividend action are equally difficult to interpret as a guide to conditions during the past year. At the Lobitos meeting Mr. H. C. R. Williamson said that the Peruvian Company from which Lobitos draws its principal profits should do better in 1934 than in the previous year. Sir John Cadman told Anglo-Persian shareholders that, while it was impossible to forecast the trend of general trade, the company's business was increasing. The Burmah Chairman, on the other hand, dwelt on the keen competition in the Indian market owing to the sale of American, Russian and Roumanian surplus production.

Recent oil dividend and profit statements also fail to disclose any definite business trend. Shell Transport and Anglo-Persian have both decided not to pay an interim dividend for 1934, but no definite deduction can be drawn from this fact, since no interim distributions were made for 1933. An unfavourable light on the position in the British market was thrown by the Trinidad Leaseholds annual report, made up to June 30, 1934. The figures showed that while products sold during the year totalled 952,798 tons, against 865,151 tons in 1932–33, revenue declined by £72,195 to £430,679, and called for a reduction in the aggregate dividend from 15 percent to 12½ percent. Shareholders were told at the meeting in November that results for the current year could be considered satisfactory "under existing circumstances." Although British conditions are unfavourable, possibilities of improvement in some overseas countries are suggested by the increase in the Anglo-Ecuadorian dividend announced at the beginning of December.

British selling prices, which are most likely to affect Anglo-Persian and Trinidad Leaseholds among the principal British producers, were less favourable in 1934 than in 1933. First grade motor spirit, for example, started 1933 with a retail price of 1s. 7½d. per gallon, which persisted until May 17. It was then reduced to 1s. 5d. but was raised to 1s. 6d. on November 3. Average price for the year, taken on a daily basis, was thus approximately 1s. 6.1d. per gallon. Starting 1934 at 1s. 6d., the price was cut on March 22 to 1s. 5d., and that quotation has since remained unchanged. This gives an average of 1s. 5.2d. per gallon for the whole year, and the decline of practically 1d. per gallon in 1934 against 1933 naturally comes out of any profits made by producing companies.

Against the lower level of British selling prices for oil products, however, there must be set the increase in the consumption of practically all categories, which is indicated by an advance of 5,691,404 bbl., or more than 10 percent, in the total of imports of petroleum into Britain during the first nine months of 1934 compared with the corresponding period of 1933.

It may therefore be assumed that on an average the profits of British petroleum companies for 1934 will not show any improvement on those for the preceding year, although they may not fall far short of the 1933 figures.

Fluctuations in Stock Exchange values for oil shares during the past year have been disappointing. Under the influence of hopes of effective control of the United States petroleum industry, prices rose substantially until the March cut in British motor spirit prices was announced. This administered a shock to confidence from which the market has not recovered. Failure of United States measures to check over-production has been another adverse factor, since the American position has seriously affected the selling prices of British companies, in whatever market they operate.

Share prices are not likely to receive any stimulus from the 1934 results, and current conditions of market inertia will probably persist until conditions in the United States improve. Meanwhile, British oil companies generally, including all the major concerns, enjoy the advantage of sound and conservative finance, and are equipped to obtain early benefit from recovery in selling prices. Definite evidence of a real improvement in the American position, whether by the decline of flush fields or by the application of an effective check on production, would undoubtedly be reflected in a sharp upturn in oil share prices in London.

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Will Afghanistan Oil Enter World Markets?

A Valid Concession Covering the Development of the Petroleum Reserves of Afghanistan is said by a San Francisco Attorney to be Presently in Force and Exploitation May Start Soon.

DEVELOPMENT of large reserves of petroleum in Afghanistan would, if this oil became available, add a new and potent factor to the Far Eastern petroleum situation. But do such reserves exist in that country and could they be made available? The facts on which the accompanying article is based were supplied to World Petroleum by parties actively interested in the concession. As constituting an unusual and possibly important development it is published herewith: but the accuracy of the statements involved is not guaranteed by World Petroleum.

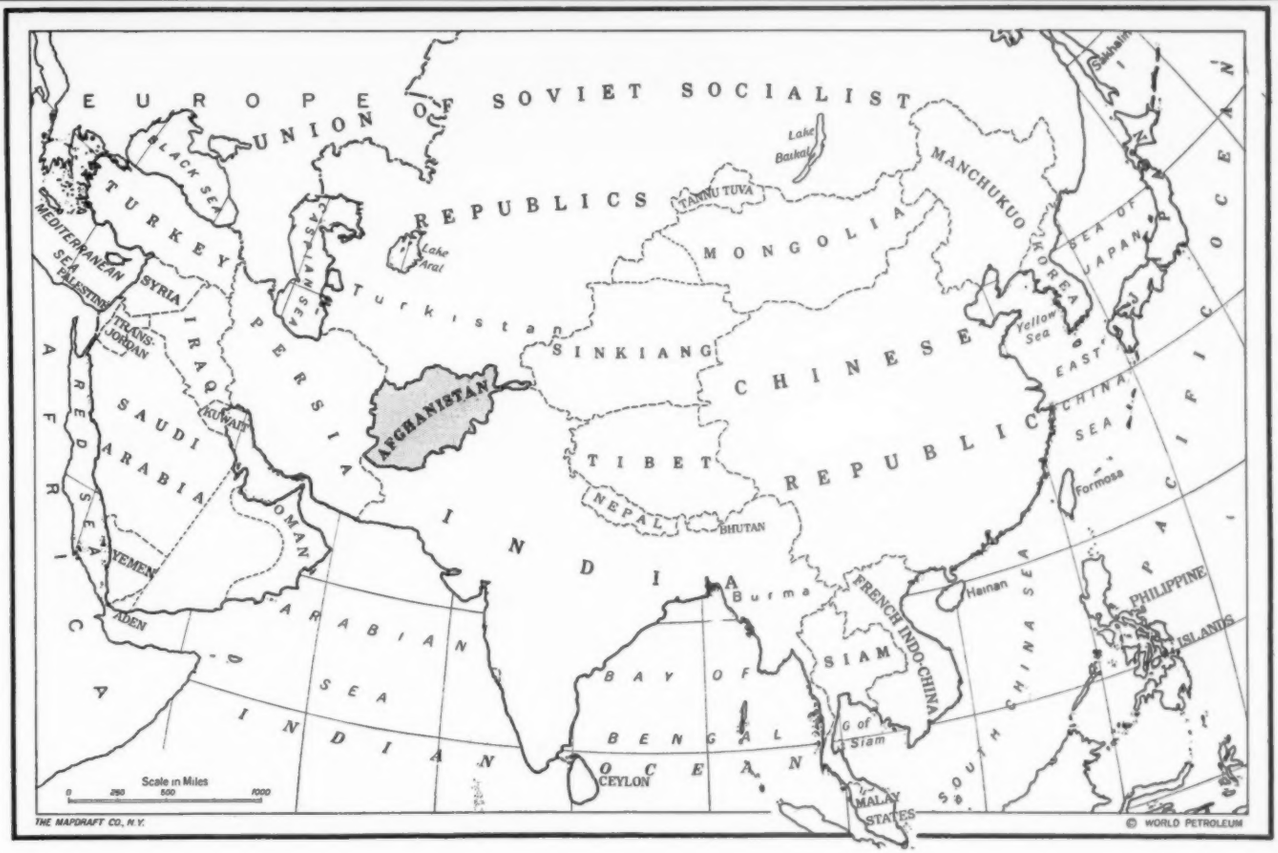
POSSIBILITY for development of petroleum in Afghanistan is again receiving consideration following announcement that a concession granted a California attorney several years ago is considered as still in effect by the present Ameer. This concession is said to be controlled by Harry Gottesfeld, an attorney residing in San Francisco. Gottesfeld, who was retained as legal advisor in the United States to the government of Ameer Aman Ullah Khan in 1926, has recently been in conference with interests on the Pacific coast, looking toward preliminary work under the concession.

After the Afghanistan concession was granted a number of events occurred, including the abdication of Ameer Aman Ullah Khan, and the world-wide depression, which resulted in its not being acted upon. Time was an element of the concession and the periods fixed for commencement of research and development work have elapsed, but, according to Gottesfeld there has never been a cancellation of the contract by the Afghan Government.

Plans are being worked on at present for a group of American engineers and geologists to visit the district included in the agreement under the general concession pertaining exclusively to the development of petroleum.

New complications are at hand, however, again bringing time into the picture as an important element, for reports have

Harry Gottesfeld



Map of Asia showing Afghanistan in relation to the Mediterranean and the Far East and to the Russian, Persian, Arabian and Iraq oil fields.

been current that other sources are now showing an active interest in the affairs of Afghanistan.

Attorney Gottesfeld says that the character of the Afghan is similar to that of the American in so far as it concerns his love of liberty and personal independence. He says that only by giving full consideration to this, and the battle Afghanistan has carried on for centuries against Russian aggression on the North and, since Clive was in India, against the British on the South, can the admiration of these upstanding fighters for the United States be understood. The Afghanistan government, he says, is confident that development of natural resources, highway systems, industries and establishment of schools can best be obtained with the aid of American capital, and this without danger of sacrificing territorial, political and religious independence.

This agreement by a group of Americans to undertake the development of resources in remote Afghanistan says Mr. Gottesfeld had its inception in an acquaintance between himself and a representative of the Asiatic state, who in 1926 was in California in the interest of agricultural development in his country. The Afghan had an idea that students from his country might come here, take up land and work it under guidance of the extension service of the university and become thoroughly ac-

Original agreement for the development of natural resources in Afghanistan by Americans, signed at Paris in 1927 and held by Mr. Gottesfeld of San Francisco. The oil contract was made under this concession.

quainted with American methods before returning to their native soil. The plan included a colony with a rotating population. Gottesfeld was retained to inquire in the legal phases of the matter and advised that Afghans are prohibited from owning land in California (Mr. Gottesfeld suggested an alternative plan which is now being followed by the Afghan government). He became well acquainted with his client and made a tour of the country with him.

Discussion of the entire situation including the national aims of the people, problems confronting them as a result of an age old propaganda portraying the Afghans as a murderous people because they have fought to death against foreign aggression and have been quick to check every scheme or subterfuge on the part of those seeking domination, resulted in Gottesfeld being asked to submit a plan for national development of Afghanistan. This was forwarded to the Ameer together with catalogues and detailed reports on American industry.

The Ameer had sought to visit the United States in person during the Harding administration but as the necessary invitation was not forthcoming from the President, the Ameer decided to visit European countries.

In Paris in 1927 an agreement of wide scope covering the development of Afghanistan with the aid of American capital was entered into between the Afghan government and Gottesfeld. This included the development of all natural resources including petroleum, and resulted in a flurry among those holding or seeking concessions in the Persian oil fields. It is claimed according to the Attorney that the field in Persia extends across the Afghan-Persia border and that the activity on the Persian side results in draining oil from Afghan formations, where only crude native development recovers but a fraction of possible production.

Returning to New York at the time the former Ameer was visiting several European capitals, Gottesfeld and his associates were advised to make a special agreement under the general concession covering development of petroleum. This was done. At that time American and Anglo-Dutch interests were not in agreement and it seemed that the Afghan oil concession might be financed at once, but the big companies reached an accord and the matter was put aside by the American oil company, says Mr. Gottesfeld.

Under the special oil concession which is some 20 pages in length, written in English and Afghan in adjacent columns it is specified that the holder shall have the exclusive right to prospect for petroleum in Afghanistan for a period of 50 years. The royalty to be paid the government to be 6 percent in kind or in American exchange and to be based on the price of oil at Liverpool, less cost of transportation. An additional 2 percent to be paid on exports of products refined from Afghan petroleum.

It is expressly stipulated that all persons entering Afghanistan in connection with this concession are to be American citizens.

Provision is made for purchase of oil by the government, this oil not to be resold in competition with the Trading Company. It is stipulated that at the end of the 50-year period all wells, refineries and other property pertaining to the petroleum industry under the concession, become the property of the state. The state also retains the right to redeem all this property at the end of thirty years at a price to be fixed by a board of survey.

Of the capital required 51 percent is to be furnished by citizens of the United States and 49 percent by Afghanistan. Profits are to be shared on a like basis.

Special provision is included against the sale of the concession or any interest in it to nationals of countries other than the United States.

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Oil from Coal Costly to British Industry

Besides Depriving Treasury of Revenue and Jeopardizing British Petroleum Investments of £141,000,000 It Penalizes Engineering and Shipping Industries—Coal Owners' Coolness.

BRITISH oil legislation enters a new phase with the beginning of 1935, which will see the full operation of the Hydrocarbons Oil Production bill. The policy which this measure expresses is already leading in a direction likely to inflict considerable damage on a number of important industries.

Desire of the British government to assist its languishing coal industry is understandable. To support it the usual plea that a domestic supply of light oils is necessary for the national defence has been brought into play. From the economic viewpoint, however, the coal and petroleum policy adopted is open to serious objections.

Discriminatory taxation of fuel oil entering Great Britain designedly works to give coal an advantage in competition with oil. The Hydrocarbons Oil Production bill supports competition of an equally uneconomic kind from oil produced from indigenous coal.

Passed in February 1934, the bill guarantees a duty preference of not less than 4d. per gallon on light oil produced from British coal, peat or shale over a period of nine years. Arrangements have been made whereby no duty will be charged for the present on motor spirit produced from domestic coal. There is, thus, a preference of 8d. per gallon over imported spirit. If petrol taxation remains unchanged, and no duty is imposed on British coal spirit, this position could be maintained for 4½ years, consequently giving the equivalent of a preference of 4d. per gallon over nine years. The effect of the bill is that, in any case, the equivalent of a 4d. per gallon preference for nine years will be given to producers of motor spirit from British coal.

In consideration of the encouragement extended by the Act Imperial Chemical Industries Ltd. undertook to construct a

big coal hydrogenation plant at Billingham-on-Tees. A production of 30,000,000 gal. of motor spirit per annum was the initial design of the company, and the plant was planned to come into operation at the end of 1934. It is not now expected that full production will be reached until the coming spring, but Sir Harry McGowan, chairman and managing director of the company, announced recently that an annual output of 45,000,000 gal. instead of 30,000,000 is expected.

Patents on the process employed are held by International Hydrogenation Patents Company Ltd. registered some three years ago to effect a fusion of interests between major American, British and German interests, all following the same lines of research. In addition to Imperial Chemical Industries, Standard I.G. and the Royal Dutch-Shell Group are interested in the patents which cover hydrogenation in all countries outside the United States and Germany. The oil industry has not been lagging in the development of hydrogenation and the Jersey Standard has spent huge sums on experimentation, which so far show the process a costly one, even when hydrogenating crude oil.

That very considerable hopes of a wide expansion of coal hydrogenation are entertained is evident from many official statements since the bill was passed.

Sir Harry McGowan, in the speech already quoted, said he visualised the time when hydrogenation units would be in existence throughout the country.

Referring to the I.C.I. Billingham plant, the Secretary for Mines says in his annual report for 1934:

"It has started a new development of considerable magnitude in the production of oil from coal, which, if successful, offers possibilities for the production from coal of a material proportion of the imported petrol at present consumed in the country."

A similar line was taken in the recently issued reports of the four commissioners who inquired into the possibilities of improving conditions in the depressed areas of Great Britain. Emphasis was laid in these reports on the prospect of absorbing labour by the installation of coal-oil production plants.

Under the stimulus of official encouragement and the guaranteed rebate, great activity has developed recently in formulating and extending schemes for producing motor spirit from coal, apart from the I.C.I. undertaking. Coal-oil companies have been in existence in Great Britain for something like thirty years, although up to the present they have not been financially successful.

The oldest of the existing concerns now engaged in planning increased output is Motor Fuel Proprietary, Ltd. Formed in 1909, this company now announces that it has changed its name to Coal and Allied Industries Ltd., and has developed a new and unique coal and oil carbonising process. A site has been secured in the same area as the I.C.I. plant, and the company proposes to erect an installation which it claims is capable of handling 500 tons of coal a day and producing 27 gallons of light oil from each ton of coal. The annual output of this plant should therefore be about 4,000,000 gal. The directors anticipate that the demands for the company's products will call for the immediate erection of further plants of similar capacity.

Another active undertaking is the National Coke and Oil Company, which has a plant at Cannock for the treatment of 150 tons of coal a day. According to this company's figures, 18 to 20 gallons of motor spirit will be produced from each ton of coal consumed, and the plant is planned for a daily output of 3,000 gal. Preparations are being made by this company for the erection of six similar plants in other centres, and this amount may be increased later. On the basis of only seven plants, the company's projected output is over 6,000,000 gal. a year.

Plant extensions are also being planned by Low Temperature Carbonisation Ltd. a company which was formed in 1919, and which is now finding the outlook for its products so improved by the government preference that it is extending the scope of its operations.

In the accompanying table the projected output of these companies is converted into barrels, a reasonable estimate being made for the potential production from the Low Temperature Carbonisation and other plants.

Since British imports of motor spirit for 1933 amounted to 30,760,045 bbl. the total of coal-oil production in sight at the moment amounts to little more than 5 percent of imports. The fact remains that the initial production of 30,000,000 gal. equivalent to 857,143 bbl. on which the coal-oil preference was based has already doubled, first by the projected additional output from I.C.I., and then by the other schemes encouraged by the government's action. It is evident moreover, from statements made in various quarters that present definite plans will not be far advanced before further extensions to coal-spirit output will be planned, either by those responsible for present proposals or by others attracted by the government guarantee.

There is danger that a position will be reached within a short time when the British government will be losing a serious amount of revenue in tax rebate, and at the same time will create a fresh vested interest composed of the coal-oil producers who will be able to operate only by reason of the guaranteed preference. Experience shows that advantages given in this way to enterprises incapable of self-maintenance, create a continual demand for fresh assistance and relief.

Projected Annual Output of Coal Oil in Great Britain

Company	Barrels (Approximate)
Imperial Chemical Industries	1,285,000
Coal and Allied Industries	115,000
National Coal and Coke	170,000
Low Temperature Carbonisation and other plants	150,000
Total	1,720,000

Meanwhile, the loss of tax revenue which the government already has in sight is beginning to mount, although the Prime Minister when speaking on the Hydrocarbons Oil Production Bill, described the cost of the preference as trifling from the revenue standpoint. All the plants at present planned will participate in the preference, and on the basis of existing plans alone, and the 8d. per gal. preference at present operative, the loss of revenue will be £2,000,000 a year for at least 4½ years. This is a substantial sum in view of the universal cry of overtaxation in Britain. A point not to be overlooked is that as lubricating oil cannot, at present, be produced from coal it may result in higher lubricating oil prices due to unbalanced refining abroad.

Far more serious than the loss of revenue to the government is the loss which British firms and individuals must suffer through the development of the government's new oil policy for assisting coal at the expense of imported petroleum.

There are in Great Britain over 200 engineering works that manufacture among other products some form of equipment for the petroleum industry. One undertaking, employing over 300 workmen and staff, and in which the British government itself has an indirect interest, is engaged on practically nothing else but oil well drilling machinery. A very considerable proportion of the oil equipment produced in British engineering works is shipped abroad, and goes to swell the volume of British exports which are a vital factor in the country's economic position. For instance, over £2,000,000 in materials, labor and equipment for the Iraq pipeline has been spent in Great Britain during the past three years. The government's policy is designed to check the import into Britain of products that are partly the result of oil equipment manufactured in Britain itself. Equally important, from this standpoint, is the

construction of tankers in British shipyards.

The following table of tonnage registered and under construction in Great Britain and Ireland at the end of June, 1934, illustrates the importance of tankers to British shipping, shipbuilding, marine engineering and allied industries.

Oil Tankships Registered and Building in Great Britain

	Tonnage registered (Gross tons)	Tonnage under construction (Gross tons)
Total	17,630,000	587,142
Of which tankers	2,211,000	101,500*
Percentage of tankers in world tonnage	12.5	17.3

* (Cost £20,000,000)

Tanker tonnage, employing a large number of British officers and crew, and contributing to British invisible exports by attracting freights, represents an important part of the British mercantile marine. An even more important place in the picture of the British shipyard industry is occupied by tank-ship building. This section of the shipbuilding industry builds not only for British companies but for international undertakings. Tanker construction not only provides direct employment for ship-yards, but gives a large amount of work to steelworks and engineering shops. Home produced coal-oil must consequently affect British shipbuilding and steel centres accordingly. As a partial offset to this loss, the new coal-oil plants will provide a certain amount of work, but, as presently will be discussed, very little additional employment will be found for coal miners.

The aims of the Hydrocarbon Oil Production bill seem to overlook the fact that out of the 1s. 5d. for which a gallon of motor spirit is sold in Britain, only between 2½d. and 3½d. actually goes out of the country, and that, while Britain is undoubtedly an important market for petroleum products, the domestic and international oil companies supplying those products are themselves valuable customers of British industry. Even of the 3d. remitted abroad for petrol purchased a considerable part finds its way back into British pockets, since there are several thousands of Britons employed abroad in the search, production, refining, transport and marketing of petroleum.

Dividends to thousands of British shareholders of oil companies, as well as salaries and wages, come out of payments made by Britain for imported oils. The Bank of England, in its Statistical Summary for September, 1934, computes the nominal capital of United Kingdom investments in the petroleum industry at £141,000,000. A substantial part of this investment looks for its remuneration to the export of products to Great Britain, and every barrel of international oil kept out of the British market, if it does not directly reduce the sales of a British company, goes to increase competition on the world markets to the detriment of British oil concerns producing and selling overseas.

A careful examination of recent views on the subject suggests that the advantages of the government's policy are by no means substantial. Expert opinion entertains grave doubts as to the economic utility of hydrogenation, and the coal industry itself has no use for low-temperature carbonisation.

The view expressed by Sir Richard Redmayne in his presidential address to the Institute of Civil Engineers, when he said that hydrogenation is at present applicable to treatment of tar rather than the direct treatment of coal, typifies the uncertainty of expert observers on the value of current coal-spirit plans.

It is evident from the official estimates of the results of hydrogenation, that it is an expensive method of using coal. Discussing prospects of the process the British Prime Minister said that the I.C.I. plant would utilise 350,000 tons of coal per annum. As then planned, the plant was to produce 30,000,000 gallons of spirit, and it is therefore evident that the loss of revenue at 8d. per gallon would be £1,000,000. On this basis, each ton of coal used would cost the government over £3 in tax rebate, against a pit-head price of about 12s. per ton of coal. On the face of it, therefore, hydrogenation is a costly method of assisting the coal industry.

Mining industry views of the industrial effect of the government's policy were incorporated in the report of one of the Commissioners on Depressed Areas, both owners and miners stating categorically that they were not favorably disposed towards low temperature carbonisation. Opposition of the coal industry is not difficult to fathom, since carbonisation of one ton of coal by the low temperature processes means about 15 cwt. of smokeless fuel being placed on the market in direct competition with coal.

The heating value of this smokeless fuel received the following comment from Col. W. A. Bristow, chairman and managing director of Low Temperature Carbonisation Ltd., in a speech at the General Meeting of the Smoke Abatement Society.

"The calorific value of some of these so-called low temperature fuels (I say 'so-called' because they give the highest temperatures), is as high as 14,300 B.T.U.'s per lb.—as good as, or better than, first-class house coal. It follows therefore, that the whole of the increased radiation efficiency is enjoyed by the consumer."

This, and similar statements by the smokeless fuel manufacturers who distill coal-oil at the very same time, show the fallacy behind the British Government's policy. While they are assisting the extension of plants to produce motor spirit from coal, the owners of those plants are extolling the value of simultaneously produced smokeless fuel which is to oust household coal from the market. Naturally, the coal industry sees no advantage in selling coal to low temperature carbonisation concerns which rely for a large part of their revenue on the sale of a manufactured fuel entering into direct competition with coal. This aspect of the relations between coal-oil and coal probably was inadequately understood by the government before it embarked on its policy.

As it stands, this policy will have unfortunate reactions on important British industries; will create unnecessary economic disturbance; deplete the national tax revenue, and may even antagonise some of Britain's overseas customers.

At present the petroleum industry contributes enormously to the government's revenue. In addition to paying very large amounts in income-tax, it acts as a tax-collector without charge, collecting and handing to the Treasury the sum of 8d. on every one of the hundreds of millions of gallons of petrol sold annually. Surely, in view of the petroleum industry's big contribution to national revenue and trade, it deserves equal treatment with competing products. More than that it does not ask.

▼

THE Irish Free State Government has already made some progress in its plans for having the oil requirements of the state supplied by domestic refineries.

Following an intimation that the Minister for Industry and Commerce was prepared to consider applications for the setting up of refineries in the Irish Free State, one application has already been granted and a refinery is being established in Haulbowline Island by the Cork Harbour Oil Wharves, Ltd., for the refining of about 3,000,000 gallons of crude oil per annum. This represents only about one tenth of the total requirements of the state.

The nature of concessions to oil companies is not disclosed, but it is understood that the Minister is prepared to give adequate protection to oil companies producing in the Free State for the Irish market.

South end of the Oklahoma City field: one well to ten acres.

Geology and Economic Significance of the Oklahoma City Field

Second of a Series of Articles Dealing with Geology, Production, Reserves and Economy of the More Important U. S. Oil Fields. By Basil B. Zavoico

THE OKLAHOMA CITY field, in Oklahoma County, Oklahoma (T. 11N., R.'s 2 and 3W.), located in part within Oklahoma City, is an outstanding example of a competitively drilled and produced oil field with the attendant great waste of crude oil, of natural gas and of capital employed in the development. Discovered on December 4, 1928, Oklahoma City rapidly developed into a major oil field and at this time is the largest single field in the northern Mid-Continent district, including the states of Oklahoma and Kansas. Up to November 1, 1934, a total of 1,128 wells have been completed in the Oklahoma City field, producing to that date 247,392,000 bbl.; while a recoverable reserve of about 95,000,000 bbl. is estimated to be still available. The outstanding features of the Oklahoma City field are: 1. its discovery on the strength of surface geological work; 2. depth of 6,500 ft., to the producing formations which forced a rapid development of deep drilling and producing methods; 3. the town-lot development which resulted in drilling of some two to three hundred unnecessary wells; 4. exceptionally rich producing sands which made excellent showing in spite of wasteful methods of proration and production; and 5. poor economic showings of most of the operating companies in the field due to the overdrilling and to the waste of gas energy.

Oklahoma City field is located on a very well defined surface structure, which shows 80 ft. of closure and 120 ft. of east dip (reversal to normal western dip) on the well exposed Garber sandstone, member of Enid formation of Permian. This favorable structure has been known to exist probably since 1917, and as early as 1925 L. R. Trout drilled a well in Section 36, T. 11N., R. 3W. to a depth of 4,480 ft. and encountered in this test, before abandoning it, several small showings of both oil and gas, stopping 2,000 ft. above the Wilcox sand, where on the exactly same location Sinclair-Prairie Oil Company later completed its School Land 67 No. 5 for 20,000 bbl. per day. In 1927 the Indian Territory Illuminating Oil Company made a detailed survey of Oklahoma City area and subsequently leased about 6,000 acres on the crest of the indicated north-south elongated domal anticline.

The discovery well was drilled by the Indian Territory Illuminating Oil Company in Section 24, T. 11N., R. 3W. The operations began on June 12, 1928, and on December 4, 1928, the well, No. 1 Fee, was completed for 5,000 bbl. of 39 gravity crude and 6,500,000 cu. ft. of gas per day from the Arbuckle limestone, Canadian, topped at 6,165 ft. and penetrated to 6,402 ft. The discovery well was subsequently deepened to 6,624 ft.; it flowed naturally until March 3, 1929, producing to that date 456,599 bbl. of crude oil; salt water first appeared on March 4, 1929; by July 31, 1931, the discovery well produced 1,003,730 bbl. of oil and at that time it was plugged up to 4,820 ft. and completed as an 80,000,000 cu. ft. gas well in the Layton sand series, Pennsylvanian.

Development

IMMEDIATELY after the discovery the development of the new field progressed slowly. The I.T.I. Oil Company controlled most of the acreage within a 2-mile

radius of their No. 1 Fee, with the exception of few large tracts owned by T. B. Slick, Sinclair-Prairie Oil Company, Coline Oil Company, Shell Petroleum Corporation and Mid-Kansas Oil Company. Moreover the field was first judged by and compared with the Garber, 60 miles due north, and while conceded to be an important discovery it was not considered of primary importance. It was thought that the Arbuckle limestone would be the only producing formation in the pre-Pennsylvanian section, as was the case in the Garber field where sharply dipping Simpson sands were not productive on the edges of the truncated Arbuckle core. It was not until June 27, 1929, that production was discovered in the lower Simpson sand section by Coline Oil Company's No. 1 Olds in Section 24, T. 11N., R. 3W., half a mile due northwest from the I.T.I. Oil Company's No. 1 Fee, and still in an area solidly controlled by the latter company. No. 1 Olds was completed for 4,173 bbl. initially, with a total depth of 6,377 ft. The Wilcox sand production was opened on March 25, 1930, when I.T.I. Oil Company's No. 1 Mary Sudik in Section 31, T. 11N., R. 2W, 1½ miles due south from No. 1 Fee, blew out at 6,472 ft., flowing around 40,000 bbl. per day. Two months later, on the north end of the field, Hall-Briscoe's No. 1 Holmes in Section 10, T. 11N., R. 3W., two miles due northwest from the pool opener and practically within city limits, was brought in for 17,000 bbl. of crude oil and 14,500,000 cu. ft. of gas per day from a total depth of 6,419 ft., 20 ft. in the Wilcox sand, thus extending production into town-lot area, outside of the limits of the block assembled by the I.T.I. Oil Company. The completion of No. 1 Holmes was the starting point of very active leasing within the city limits and an intensive town-block drilling campaign followed.

Table 1

Well Completions in Oklahoma City Field

	Wells completed during year	Total number of Wells completed
1929	64	64
1930	673	737
1931	166	903
1932	138	1041
1933	65	1106
1934	22	1128

The development of Arbuckle limestone and Simpson sand zones in the Oklahoma City field progressed quite conservatively as far as well spacing is concerned, and the wells on individual leases were not spaced closer than 1 to 10 acres, while a number of operators left inside locations undrilled, bringing the average spacing in Arbuckle limestone area to 1 well to 14.60 acres, and in Simpson zone to 1 well to 12.85 acres. The development of the Wilcox sand zone assumed proportions of a near stampede and on the north end: wells were jammed in as closely as was possible, averaging one well to 2.1 acres on the west 80 acres of the northwest quarter of Section 2, T. 11N., R. 3W., and one well to 6.18 acres over the whole drilled area in the zone.

The statistical data by zones is presented in table 2.

Table 2

Production, Development, Recoveries and Estimated Reserves of Oklahoma City Field

	Total	Wilcox Sand Zone	Simpson Sand Zone	Arbuckle Limestone Zone	Fault and Upper Simpson Zone
Number acres producing	10,685	3,365	5,560	1,620	140
Number acres drained	11,685	4,365[1]	5,560	1,620	140
Number wells	1,128[2]	545	433	111	7
Well spacing, acres per well	9.45	6.18	12.85	14.6	20.0
Estimated 24-hour initial production	12,093,000	9,020,000[3]	1,885,000[4]	1,185,000	3,000
Recovery to Nov. 1, 1934 including estimated unreported oil	247,351,000	157,875,000	71,019,000	17,837,000	620,000
Recovery per well	219,500	289,300	164,200	160,700	88,500
Recovery per acre (drained)	21,200	36,100	12,780	11,000	——
Estimated future reserves	95,000,000	75,000,000	20,000,000	——	——
Estimated ultimate gross oil production—total	342,351,000	232,875,000	91,019,000		
Estimated ultimate gross oil production per well	304,000	426,000	210,000		
Per acre	29,300	53,300	16,380		
Estimated present full 24-hour potential	282,200	250,000	31,000	740	1,200
Actual October daily production	145,100	114,500	29,700	740	160

[1] 1,000 acres added to the north end, where drilling is prohibited, this area being drained by wells located due south
[2] Includes 30 wells under other classifications
[3] Initial 4-hour potential gauge x 4
[4] Initial 4-hour potential gauge x 5

The very close spacing of Wilcox sand zone wells on the north end of the field made the larger tracts, owned by single companies, and conservatively developed, a distinct liability, because the densely spaced tracts recovered oil from a large surrounding area, and accordingly the relative importance of holdings of the various companies is now definitely based upon the number of wells drilled, rather than acreage.

It is quite difficult to arrive at an equitable figure of remaining recoverable reserves in Oklahoma City field. While the estimates given here credit the field with a recoverable reserve of 95,000,000 bbl., the actual recovery may vary around 20 percent either way, depending upon the lifting costs and price of crude oil. Thus while in the Seminole area wells are now actually produced at a profit pumping 10 bbl. of oil and 15 bbl. of salt water per day from around 4,200 ft., in Oklahoma City the present absolute minimum economic limit is 25 to 30 bbl. of oil and not over 100 bbl. of salt water per day, which naturally reduces both the life of the field and its ultimate recovery. However, any increase in the price of crude oil will allow correspondingly longer life to the field and larger recoveries.

The Oklahoma City field is now fully developed. About 1,000 undeveloped acres are considered proven on the north end of the field, within the Wilcox sand zone, but located within part of Oklahoma City where drilling is still prohibited. If the city opens for drilling additional town-blocks, which is unlikely at this time, more wells will be drilled on the north end. This undeveloped acreage has been largely drained by wells located to the south, and it is questionable whether intense development to the north would be profitable; at best, a few wells strategically located and spaced one to 15 or 20 acres on unitized city blocks would be advisable.

Proration History

WITH A large number of producers exceeding 15,000 bbl. per day, proration of the Oklahoma City field became an economic necessity, and as early as in September of 1929, the first production control measures were applied. The original curtailment was on a "time plan" allowing wells so many hours of production each day, a plan which contributed greatly to waste of gas reserves since most operators naturally did everything possi-

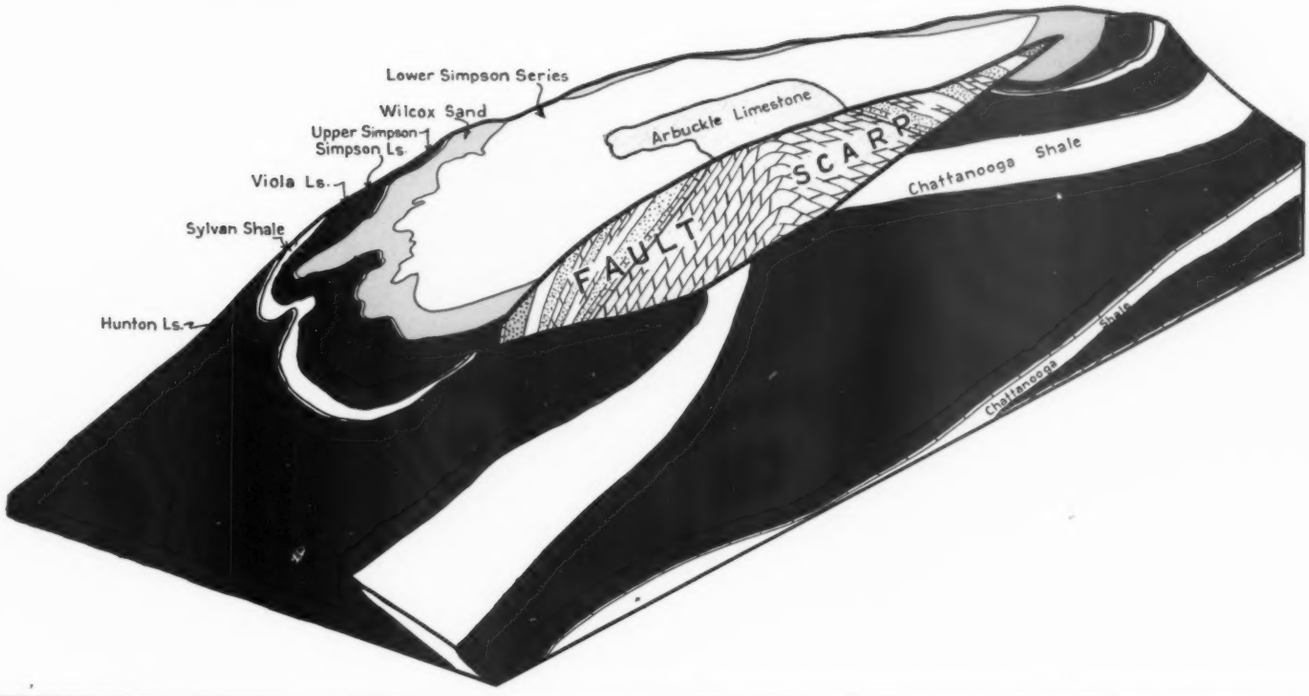


Figure 1.

Relief model of Oklahoma City field structure stripped of Pennsylvanian and Permian sediments, looking northwest and showing progressive truncation, fault and fault scarp.

ble to increase the flow; the "time plan" was superseded by "percentage plan" on January 3, 1931. At first the curtailment was on the basis of agreements between a few large operators in the field, sanctioned by the State Corporation Commission, and was relatively successful, if not in the best interests of conservation; but subsequent to Wilcox sand zone development within the city limits all semblance of orderly proration disappeared. Operators, both majors and independents, were equally to blame, each trying to promote their interests, neither group agreeing even among themselves, while state politicians watching the game in actual fact from the windows of the Capitol contributed freely to the impasse. The wells were drilled into the sand as rapidly as possible, casing was set to take in both oil and gas saturated sections, gas was blown into the air in huge volume to bring in oil in the higher sections of the field, and at one time it was conservatively estimated that 75 wells had an oil-gas ratio in excess of 10,000 cu. ft., and a large volume of oil was being produced illegally, unreported to the Corporation Commission, Tax Commission, or land owners. The total illegally produced "hot" oil in Oklahoma City field is estimated at around 14,000,000 bbl., of which, however, about 8,000,000 bbl. were reported to the Tax Commission.

The flood of "hot" oil from Oklahoma City and the contemporaneous ascendancy of the East Texas field forced the break in crude oil prices in March of 1931, and by June of that year posted prices dropped to 22 cents per barrel. Several Oklahoma City producers preferred to close in their wells entirely, and in July the Oklahoma City operators and land owners appealed to state authorities for radical enforcement measures. On August 4, 1931, Governor Murray issued an executive order declaring martial law for 50 ft. around each producing well and ordering military control to close all prorated oil wells. On October 1, 1931, Colonel Cicero I. Murray was given sole authority in the field and on October 10 the field was reopened with an allowable of five percent. Subsequent enforcement of proration by the Corporation Commission still proved to be ineffective and on June 6, 1932, the military order was invoked actually to prorate production, extending martial law around each storage tank and all pipelines, which were required to be equipped with meters. Oklahoma City field was again shut down entirely, with the exception of wells making oil and salt water, from March 3 to 14, 1933, by the executive military order. Finally on April 6, 1933, the House of Representatives and the Senate of the State of Oklahoma passed the famous Proration Law House Bill 481, approved by Governor Murray on April 10, which became a standard for other states and which was used later by the federal authorities. House Bill 481 was found to be an efficient measure for an enforcement of proration in the state, and it has been the foundation of all orders of the Corporation Commission since. The proration staff required by the bill was named on April 11, 1933.

The fundamental weakness of any satisfactory law passed four years after the discovery of the field was self evident and in the case of Oklahoma City field all that could be done was to ameliorate conditions slightly by eliminating illegal production. One of the principal defects of the old regime, however, was carried over: namely, the proration based upon well potentials without any regard to acreage; but in fairness to the Corporation Commission it should be indicated that pro-

ration including acreage considerations would have been extremely difficult and even unfair to enforce in Oklahoma City after all drilling was completed. At this writing the allowable production from the Wilcox sand zone of around 115,000 bbl. per day is definitely too high considering the reservoir conditions and in the interests of conservation should be reduced to around 50,000 bbl. per day.

Closely drilled west side of the Oklahoma City field, Wilcox sand production. The city may be seen in the background.

The expensive experience of Oklahoma City field establishes four major factors of utmost importance for future control of flush oil fields:—

1. Regulation of well spacing not to be closer than one well to ten acres, with some special authority to enforce such spacing within limits of various cities, if necessary, by forcing lease and royalty unitization in ten-acre blocks;
2. Enforcement and close supervision of casing programs in order to conserve the gas energy;
3. Allowable per well to be based upon both potential and acreage basis, with specific provisions for taking fair potential tests;
4. Complete records of all operators to be open to the Corporation Commission. In Oklahoma City field such a determining factor for proration as the bottom-hole pressures was and is kept secret by three principal operators.

Drilling Practice and Costs

UNTIL THE discovery of Oklahoma City field the Greater Seminole was the deepest major producing area in Oklahoma and Kansas. The Wilcox sand was encountered in that district at around 4,200 ft. and therefore the increase in depth to around 6,500 ft. in Oklahoma City was very appreciable. The drilling contractors, therefore, who did all drilling in Oklahoma City and in Seminole, were faced with entirely new requirements of deeper drilling, but within one year adapted their equipment to the new field.

All drilling is done with rotary tools of heaviest type. Standard derricks 122 ft. high are used measuring 24 x 24 feet at base. Steam power is used exclusively inasmuch as natural gas is supplied to the boilers usually free of expense, either by other wells of same operator, or by owners of natural gasoline plants in exchange for the privilege of buying natural gas upon completion of the well. The four 125-horse power, 300–350 lbs. working pressure boilers, usually used in drilling operations, consume about 1,000,000 cu. ft. of gas per day and with the average drilling time of 70 days the volume of natural gas used in drilling 1,128 wells reached a very substantial volume of 79,000,000,000 cu. ft. All this gas was derived from Oklahoma City field and it represents at the current price of 8 cents a thousand cubic feet a value of $6,320,000 or about $5,610 per well.

Deeper drilling required efficient weight control on drill pipe and weight indicators have been a standard equipment on all drilling rigs in Oklahoma City field. The drilling contracts provided for maximum allowed angle of deviation of 4 degrees since early in 1931, 6 and 7 degrees deviation having been permitted before, with the result that most wells in Oklahoma City are comparatively straight.

The average time of drilling in and completing a producer in Oklahoma City field was 113 days in 1930, but it declined to 77 days in 1931 and to 65 days in 1933 and 1934; record completions in 1933 and 1934 have been made in 35 days.

The accepted casing practice includes a minimum of 250 ft. of surface pipe cemented with 250 sacks; 5,200 to 5,700 ft. of 9⅝-inch casing set in either Checkerboard or Oswego limestones and cemented with a minimum of 1,500 sacks; and 6,000 to 6,550 ft. of 6⅝-inch or 7-inch flow string set at or near the top of the producing horizon and cemented also with a minimum of 1,500 sacks. A few wells, after setting surface pipe, drilled to the producing formation and set 9⅝-inch flow string, but this practice was prohibited by the Corporation Commission as a conservation measure. It should be particularly noted at this time that the flow strings were uniformly set at or above the top of producing horizons, because this practice has cost the operators endless amounts of money indirectly and directly. First—the setting of casing above the producing formation leaves all gas saturated section of sand exposed in the well and accounts for huge gas-oil ratios in Oklahoma City, whereas setting of casing but 50 to 75 ft. into the sand would have greatly prolonged the flowing life of the field, but such practice would have reduced potential production of wells, and since proration was based on potentials alone operators greatly preferred larger allowables to long life of the field; and second—the flow strings set in great haste of completions not only were

not set on the top of the sand but actually, in hundreds of instances, stopped 40 to 50 ft. short of sand and in shale which after a drop in bottom-hole pressures and saturation with oil and water became mud, clogging the holes and forcing expensive and protracted cleaning-out jobs.

Table 3

Size of Flow String Casing in Oklahoma City Pool

Size of Casing (inches)	9⅝	9	8⅝	8¼	7	6⅝	5⅜	5	4½
Number of Wells	2	52	2	2	393	436	4	3	6

An entirely new practice of completion of producers, for the Mid-Continent, was evolved in Oklahoma City. While formerly after reaching producing horizons with rotary equipment wells standardized and drilled into the pay with cable tools, in Oklahoma City field after setting the flow string the operators drilled into the pay horizons with smaller rotary The wells were subsequently brought in by connecting with separators, either with or without bailing depending on the reservoir conditions. Surface connections usually include three heavy duty, 5,000 lbs. master gates, operated by extensions located at least 50 ft. from the well. One to four 7 x 24-foot separators are installed on each well for initial tests.

Table 4

Analysis of Drilling Costs in Oklahoma City in 1934.

To lease investment		$30,000
Including: Derrick and its erection	$1,800	
2-1,500 bbl. tanks	1,600	
Surface connections	900	
1-oil and gas separator	950	
3-5,000 lbs. master gates	750	
290 ft. of 15 ½-inch casing	925	
5,800 ft. of 9 ⅝-inch casing	13,900	
6,400 ft. of 7-inch casing	8,800	
To drilling		$50,000
Including: Labor	$7,500	
Compensation Insurance	1,500	
Hauling	3,000	
Supplies	1,500	
Repairs	6,000	
Cones and Bits	12,000	
Cementing	2,200	
Replacements	1,500	
Water	1,200	
Depreciation of drill pipe (50 cents per foot of hole)	3,250	
Depreciation of machinery (25 cents per foot of hole)	1,625	
Gas fuel (no charge in Oklahoma City)	.....	

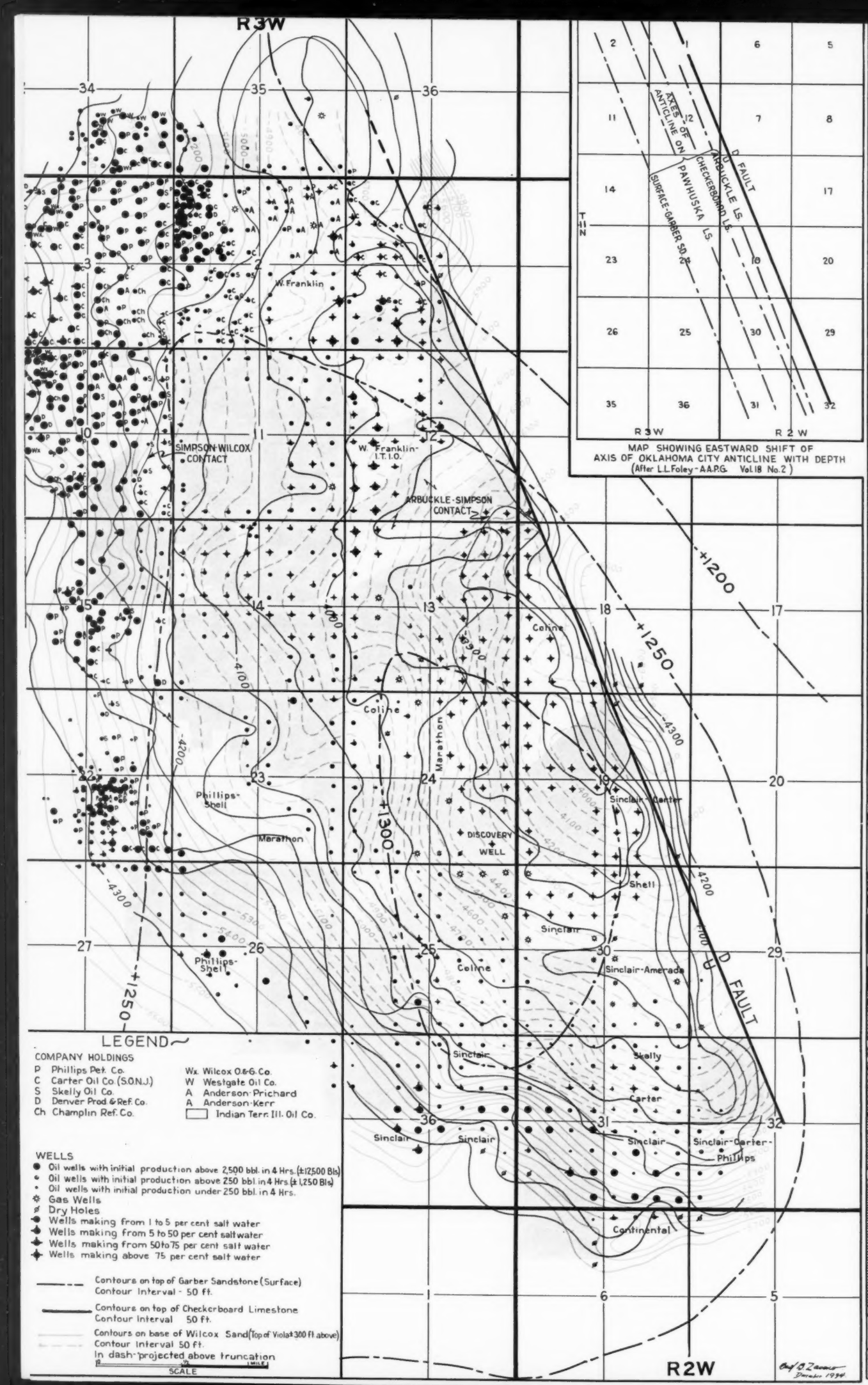
rotary wells today, unless more expensive coring is resorted to.

The cost of a completed and fully equipped well in Oklahoma City in 1929 was approximately $155,000, subsequently dropping to around $110,000 in 1932 and to about $90,000 in 1934. Drilling "contract" price starting with $12.55 per foot, $81,500 for 6,500 ft., declined to $5.15 per foot in 1934 under the NIRA code, $33,500 for 6,500 ft., these prices including only actual cutting of the hole. With many blocks within Oklahoma City limits owned by small operators it became an accepted practice to pay drilling contractors with oil to be produced, contracts of this kind carrying oil payments in amounts two to three times the standard contract. Drilling contractors in turn discounted these contracts at 50 to 75 percent of their face value to willing investors.

The average cost of all wells, fully equipped, in Oklahoma City may be estimated at $120,000, to which must be added about $7,500 per well for cost of lease, its improvements and maintenance, or a total average cost of a completed flowing well of $127,500; bringing the total for 1,128 wells drilled in Oklahoma City to $143,800,000. These costs do not include re-equipping the wells for gas-lift and pumping, which will be discussed under production.

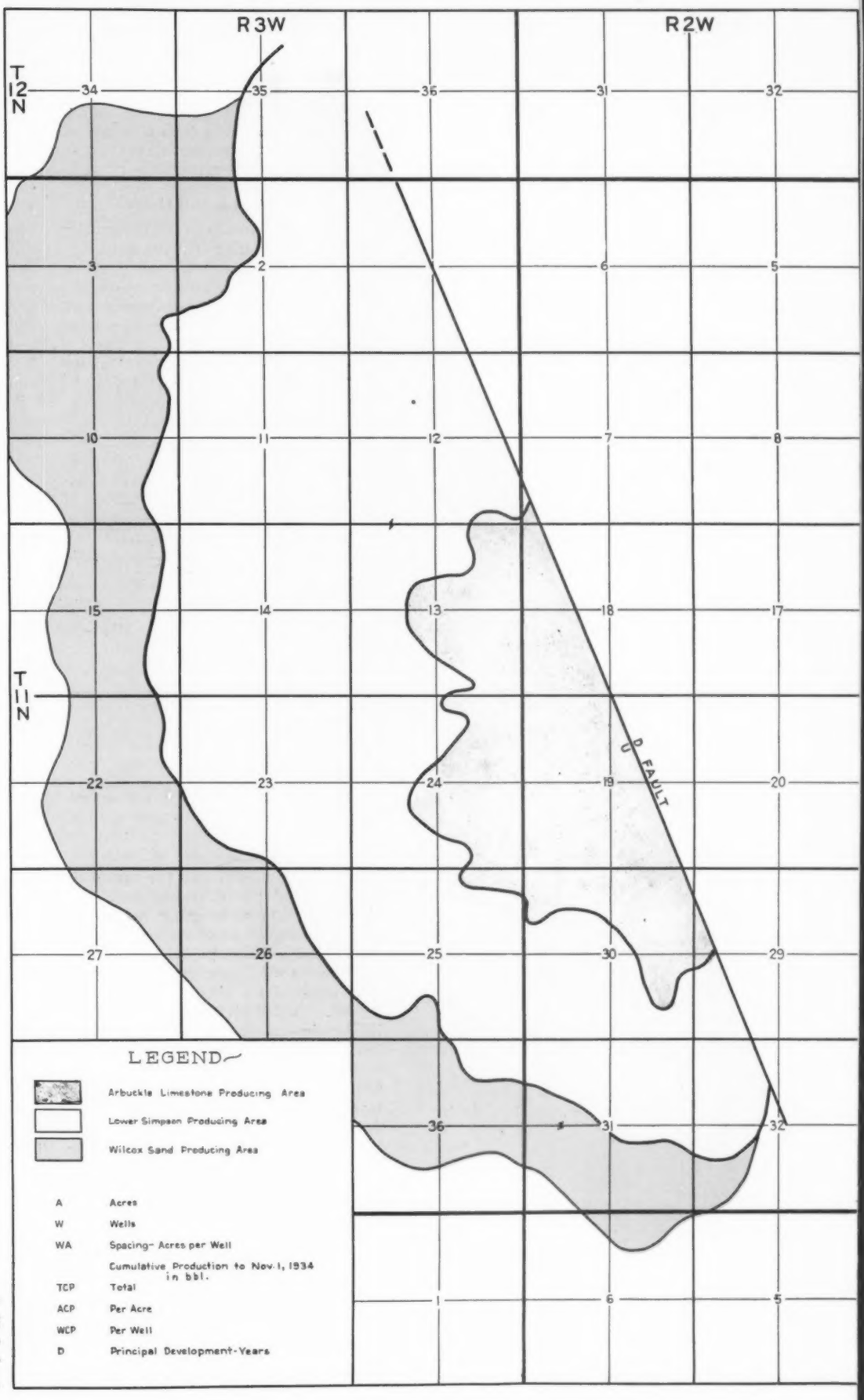
An improved road running through the south end of the field where one well to 10 acres has maintained orderly development.

Also a great improvement was made in Oklahoma City in connection with taking samples in rotary holes. While formerly rotary cuttings were considered next to worthless, various methods were developed in Oklahoma City which resulted in acceptable logs, though it is still possible to pass thin oil or gas saturated horizons in


R3W
R2W
T11N
MAP SHOWING EASTWARD SHIFT OF AXIS OF OKLAHOMA CITY ANTICLINE WITH DEPTH
(After L.L.Foley - A.A.P.G. Vol.18 No.2)
AXES OF ANTICLINE ON
ARBUCKLE LS.
CHECKERBOARD LS.
PAWHUSKA LS.
SURFACE-GARBER SD.
D FAULT
SIMPSON-WILCOX CONTACT
ARBUCKLE-SIMPSON CONTACT
W. Franklin
W. Franklin-I.T. I.O.
Coline
Marathon
Phillips-Shell
DISCOVERY WELL
Sinclair-Carter
Shell
Sinclair
Sinclair-Amerada
Skelly
Carter
Sinclair-Carter-Phillips
Continental
+1200
+1250
+1300
4100
4200
4300
LEGEND
COMPANY HOLDINGS
P Phillips Pet. Co.
C Carter Oil Co. (S.O.N.J.)
S Skelly Oil Co.
D Denver Prod & Ref. Co.
Ch Champlin Ref. Co.
Wx Wilcox O.&G. Co.
W Westgate Oil Co.
A Anderson-Prichard
A Anderson-Kerr
Indian Terr. Ill. Oil Co.
WELLS
Oil wells with initial production above 2,500 bbl. in 4 Hrs. (±12500 Bls)
Oil wells with initial production above 250 bbl. in 4 Hrs (± 1,250 Bls)
Oil wells with initial production under 250 bbl. in 4 Hrs.
Gas Wells
Dry Holes
Wells making from 1 to 5 per cent salt water
Wells making from 5 to 50 per cent salt water
Wells making from 50 to 75 per cent salt water
Wells making above 75 per cent salt water
Contours on top of Garber Sandstone (Surface) Contour Interval - 50 ft.
Contours on top of Checkerboard Limestone Contour Interval 50 ft.
Contours on base of Wilcox Sand (Top of Viola ± 300 ft above) Contour Interval 50 ft.
In dash-projected above truncation
SCALE
ABOVE SEA LEVEL
GARBER SAND (contoured black)
NEVA LIMESTONE
PAWHUSKA LIMESTONE
CARMICHEL SAND
HOOVER SAND
OREAD LIMESTONE
ENDICOTT SANDS
TONKAWA LIMESTONE
TONKAWA SANDS
LAYTON LIMESTONE
LAYTON SAND SERIES
CHECKERBOARD LIMESTONE (Contoured blue)
FIRST OOLITIC LS.
SECOND OOLITIC LS.
OSWEGO LIMESTONE
PRUE SAND
CHEROKEE FORMATION
MISS. LS.
CHATTAN. SH.
HUNTON LIMESTONE
SYLVAN SH.
VIOLA LS.
SIMPSON LS.
WILCOX SD. (Contoured yellow)
GREEN SH. ZONE
UPPER MIXED ZONE
LOWER MIXED ZONE
STAMPER ZONE
ARBUCKLE LIMESTONE
ENID
WELLINGTON
STILLWATER
PENNSYLVANIAN
MISS. DEVONIAN
SILURO
ORDOVICIAN
SIMPSON SERIES
CANADIAN
OZARKIAN
UPPER CAMBRIAN
PRE CAMBRIAN
LEGEND
Shale
Sand
Limestone
Dolomite
Granite
Scale

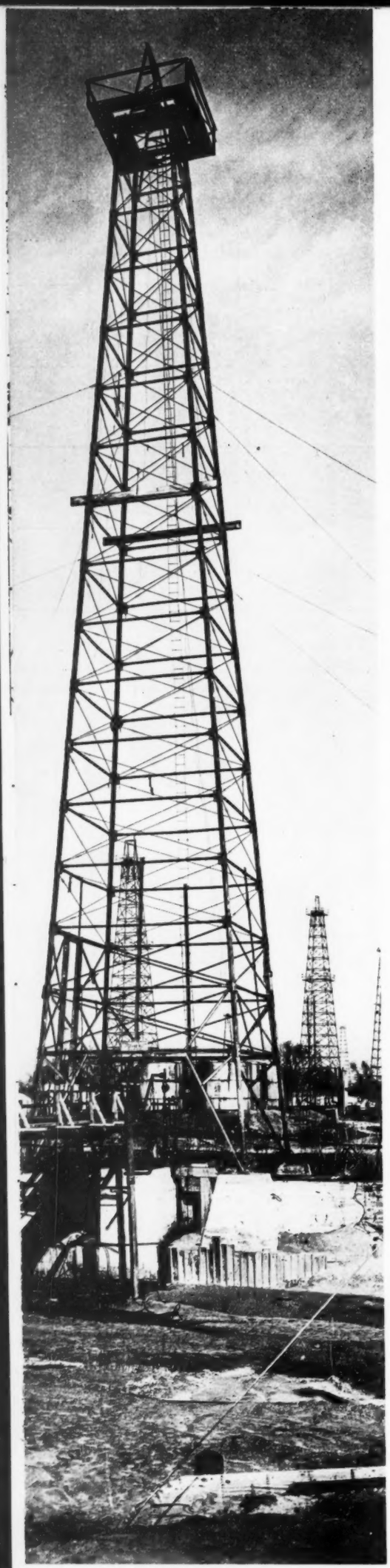
Map No. 1

Subsurface structure and development map and geologic section of Oklahoma City field. Contours drawn on Garber sandstone (black contour lines); on top of Checkerboard limestone (blue contour lines); and on base of Wilcox sand (orange contour lines), showing sharp relief on Ordovician formations, as compared with gentler folding in Pennsylvanian and Permian.



Map No. 2

Production map of Oklahoma City field showing total recoveries, recoveries per acre and per well by quarter sections.



An Oklahoma City derrick set in concrete piling in the town lot section of the field.

From $10,000 to $15,000 may be salvaged on each well in form of recovered casing and surface equipment at the time of abandoning the lease.

Production and Costs

INITIALLY all wells in Oklahoma City field were producing, flowing naturally, with the exception of a few edge wells in the various zones, or very recent completions. The lifting costs of flowing wells were nominal, probably averaging around six cents per barrel. The great waste of gas due to setting of flow strings above both oil and gas sections of sands, due to built up potential tests and due to wasteful flow practices during the first two years of life of the field, depleted the gas reserves in all zones very rapidly and at this time but relatively few wells flow naturally. Table 5 shows classification of Wilcox sand and Simpson sand wells in the field by their method of production at this writing.

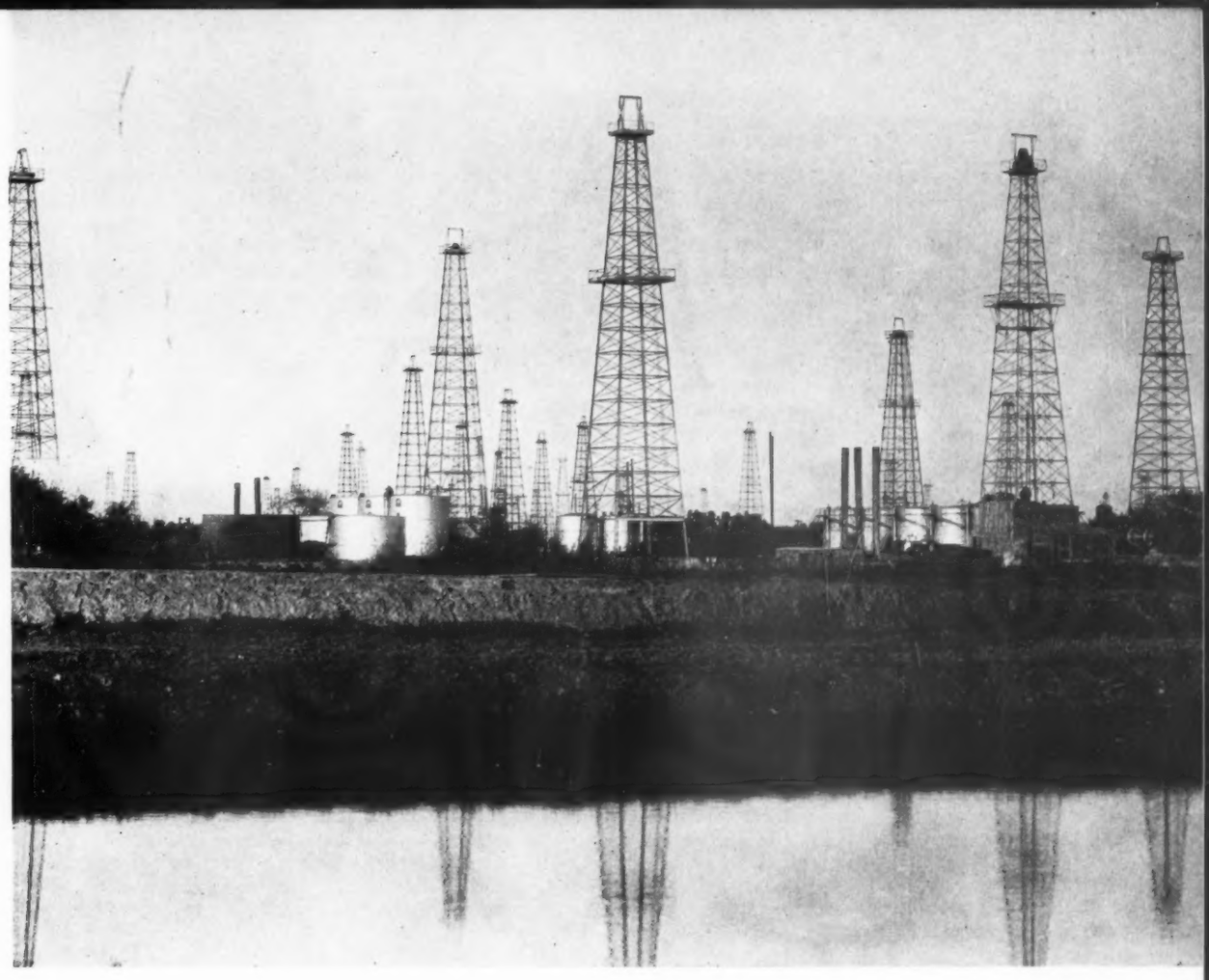
Table 5

Analysis of Producing Wells—Oklahoma City Field in October, 1934

	Wilcox Sand Zone Wells	Simpson Zone Wells	Total Wells	Percent of Total
Flowing	167	79	246	24.7
Gas lift	290	155	445	44.5
Swabbing	10	3	13	1.3
Hughes plunger lift	20	19	39	3.9
Reda pump	7	...	7	0.7
Pump	25	78	103	10.3
Shut in and reconditioning	26	71	97	9.7
Plugged up to shallow gas sands and abandoned	4	45	49	4.9
Total	549	450	999	100.0
Showing water	93	188	281	28.1

The production from the Arbuckle limestone did not offer any particular difficulties, the wells going rapidly to water. Discovered on December 4, 1928, the Arbuckle limestone zone was practically exhausted by December of 1931 when all restrictions in that zone were removed. Table 2 gives detailed statistical information on the Arbuckle zone wells. Since developed early in the life of the field the wells probably cost around $140,000 each to complete, or a total investment of $15,550,000; production costs probably did not exceed 15 cents per barrel because practically all oil was recovered by natural flow, the most expensive item of production being the disposal of salt water; thus the gross production cost was around $2,680,000. Average crude oil price in 1930 and early 1931 was $1.00 per barrel, therefore the gross receipts for oil recovered from Arbuckle limestone were $19,650,000, or net after allowing for 1/8th royalty and 3 percent gross production tax, $16,620,000. Thus the total expenditure of $19,230,000, including interest on the capital employed in drilling, brought a revenue of $16,620,000, therefore showing a net loss of $2,610,000; this may be reduced somewhat by production of gas from shallow Pennsylvanian sands, to which 60 wells have been already plugged up, and by salvage of some equipment and casing. Unquestionably considerably higher recovery from the Arbuckle limestone zone would have been possible if production was kept down to around 20,000 bbl. per day, instead of being allowed to go over 50,000 bbl. per day. Salt water disposal systems included (1) local small evaporating ponds; (2) special ponds built on waste lands and connected with the field by an 8-mile gravity 20-inch pipeline with a capacity of 200,000 bbl. of salt water per day; (3) pumping water into specially drilled shallow wells; and (4) allowing water to flow into the South Canadian river from wells near it, resulting in endless law suits and claims by farmers and cities located downstream.

The potential production of the Simpson, below Wilcox, zone, including the "Green Shale," the "School Land," the "Hammer-Haindl," and the "Kinter-Johnson" sandstones and the "Stamper" sandy dolomite (indicated in the accompanying section), declined very rapidly within the last two years, and the zone was allowed its full production in November of 1934 which by that time declined to about 30,000 bbl. per day. Considering that conservatively estimated initial production of all Simpson zone wells was 1,885,000 bbl. per day the decline has been extremely heavy. Wasteful methods of proration and production, inefficient completions of wells, as already indicated, account for the premature decline in Simpson zone production. As indicated in Table 5 only 79 wells in the Simpson zone continue flowing, while 116, or 25.72 percent, are classified as non-producers and 36 wells were plugged up to shallow Pennsylvanian gas sands. Water encroachment has been very pronounced in the Kinter-Johnson sand, this zone having been first probably flooded from the Arbuckle limestone through faulty cement-



Close spacing of wells in the north section of the Oklahoma City field.

ing jobs, edge water appearing later. On the other hand lack of any considerable volume of water in Upper Simpson sands ("Hammer-Haindl," "School Land" and "Green Shale") together with low bottom-hole pressures apparently retains the oil in these sands with the exception of small trickle. The bottom-hole pressures in the Simpson zone originally were around 2,650 lbs., but currently have dropped to as low as 175 lbs. probably averaging 225 lbs. over the whole field. The ultimate Simpson sands zone balance sheet is as follows: cost of drilling $55,250,000; cost of equipping 400 wells for gas-lift and later for pumping, including cleaning-out, at $17,500 per well, $7,000,000; cost of lifting oil at an average of about 20 cents per barrel $18,000,000; interest on capital employed at 5 percent for 3 years about $5,000,000; or a total cost of $85,250,000. At 90 cents per barrel the gross receipts on ultimate recovery will be $82,000,000; or net of $69,300,000 after royalty and gross production tax reductions, thus indicating a net loss of $15,950,000 on Simpson zone development. The spacing of wells in the Simpson zone was quite conservative, but gas waste has been very large, and more efficient production practices would have greatly prolonged the flowing life of the zone and increased its recovery. The average gas-oil ratio for the Simpson zone probably was 6,000 cu. ft. of gas per barrel of oil, or a total volume released from the reservoir to date of 426,000,000,000 cu. ft.; probably oil could have been produced from Simpson zone with a gas-oil ratio of 3,000 cu. ft., thus suggesting a loss and waste of 50 percent of gas energy originally available in the Simpson below Wilcox zone. At this writing Simpson zone wells are not prorated and average around 70 bbl. per day each.

The Wilcox sand zone is by far the more important producing horizon in Oklahoma City. Some of its wells on the north end of the field had an indicated initial production in excess of 100,000 bbl. per day, while wells in the gas zone of the sand showed up to 200,000,000 cu. ft. of gas per day. The initial production of all Wilcox sand wells based upon four-hour potential tests multiplied by four was 9,020,000 bbl. per day; as compared with current estimated actual potential of 250,000 bbl. per day. If the waste of gas energy and inefficient methods of development and production have been subject to much criticism in the Arbuckle and Simpson zones, the same factors were greatly accentuated in the Wilcox sand. By comparison with the two inner zones, the Wilcox sand zone presented an ideal reservoir condition. Separated from the Simpson zone by some 100 ft. of impervious shale bed, the Wilcox sand was isolated and could have been conservatively drilled and produced, regardless of the Simpson zone developments. Instead, a rapid drilling campaign not only repeated former mistakes, but made them worse. Wells were spaced as closely as possible, one to two acres in some portions of the field, casing was set above the sand to take in the maximum section and to build up large potentials, wells were produced for crude oil disregarding the waste of gas, and oil was illegally produced by a great number of operators because it could not be expected that some owners would let their offsets 50 ft. away flow wide open while they remained shut down. It is not, therefore, surprising that the original bottom hole pressure of 2,650 lbs. dropped to an estimated average of 300 to 350 lbs. by November of 1934. The Wilcox sand zone in December of 1934 was still allowed to produce 115,000 bbl. per day, probably 65,000 bbl. in excess of the advisable maximum, under which the reservoir conditions could become better equalized.

Under present allowable and large local withdrawals in closely drilled areas rapid water encroachment in a channel manner is inevitable. The ultimate Wilcox sand zone balance sheet appears as follows: cost of drilling $69,500,000; cost of equipping 500 wells for gas-lift and later for pumping, including cleaning out, $8,750,000; cost of lifting oil at an average of about 17½ cents per barrel, $40,900,000; interest on capital employed about $5,000,000; or a total cost of $124,150,000. Inasmuch as 340 wells would have been sufficient for the development of the Wilcox sand zone, some $30,000,000 was unnecessarily spent on drilling. At $1.00 per barrel, production probably extending over a period of higher crude prices, the gross receipts on ultimate recovery will be $232,875,000, or net, after royalty and gross production tax deductions, of $197,000,000, thus suggesting a net profit of $72,850,000. It may be definitely indicated that even mildly conservative development of Wilcox sand zone could have recovered probably from 300,000,000 to 325,000,000 bbl. The average gas-oil ratio for the Wilcox sand zone was probably at least 6,500 cu. ft. per barrel of oil, or a total minimum volume released from the reservoir to date of 1,026,000,000,000 cu. ft. Considering very uniform sand conditions in the Wilcox zone, it would have been possible to produce oil with a gas-oil ratio not to exceed 2,000 cu. ft., indicating an apparent waste of some 700,000,000,000 cu. ft. The great importance of the Wilcox sand zone is indicated by the fact that to date in that zone one well produced in excess of 1,000,000 bbl. (Oils Incorporated No. 1 Ross in Section 2, T11N., R. 3W–1,365,866 bbl.); 19 wells exceeded 700,000 bbl. recovery and 63 wells passed 500,000 bbl. A few wells with exceptional recoveries were also completed in Arbuckle limestone and Simpson sands, but in these zones high recoveries were due primarily to early completions.

Production Practices

UNTIL January 3, 1931, the proration of Oklahoma City field was based on "time plan," allowing the wells to flow so many hours per day, which naturally resulted in all wells flowing wide open. When "percentage plan" was introduced many operators continued to take all their allowables in the first few days of the month disregarding all conservation measures, and even by the end of 1931 only about one-half of all Wilcox and Simpson sand wells were equipped with chokes. At that time it was estimated that there were some 75 wells in the field with an oil-gas ratio in excess of 10,000 cu. ft. per barrel of oil, with a few wells producing in excess of even 500,000 cu. ft. of gas per barrel of oil; unused gas blown into the air at the end of 1931 was estimated to be in excess of 1,000,000,000 cu. ft. per day. Even controlling the gas-oil ratio with chokes only was found sufficient to cut the ratio to around 2,000 cu. ft. per barrel of oil; while setting casing through the upper section of the sand might have made 1,500 cu. ft. gas-oil ratio attainable. In actual flowing practice the gas waste was due to direct waste, when operators blew only gas on structurally high wells to suck in oil, and to indirect waste, when due to sudden or rapid release of pressure at the bottom of the hole, while wells were flowing wide open, gas "bubbles" formed in low pressure areas and on subsequent openings wells blew only gas for several hours. In actual experience a gas volume of 100,000,000 cu. ft. per day was noted in certain oil wells, and these wells were allowed to blow themselves into oil which required occasionally as much as one full day. A step forward was made by the Corporation Commission on February 15, 1932, when an order was issued permitting the transfer of allowable oil production from high gas-oil ratio wells to any other well on the lease, saving an estimated volume of 50,000,000,000 cu. ft. of gas. Lifting costs of flowing wells in Oklahoma City field probably average six cents per barrel.

After flowing wells stop producing or decrease their production gas-lift is applied. Three-stage compressors, designed for 1,500 lbs. working pressure, are used; kick-off pressures range up to 800 lbs., while working pressures average around 350 lbs. Fluid levels are usually fairly high in wells using gas-lift, averaging around 4,000 ft.; the tubing is usually submerged from 1,500 to 2,000 ft., therefore necessitating a lift of around 4,000 ft. The average cost of installing gas-lift equipment in Oklahoma City field is about $5,000 per well, of which $2,500 is subject to salvage. Lifting costs by gas-lift may be estimated at 20 to 45 cents per barrel, depending upon the production of the well and the volume of salt water produced with oil. It appears that even the gas-lift stage life of Oklahoma City is very limited because in the near future gas will not be available. At this time 433 wells are producing on gas-lift, with maximum potential of around 1,500 bbl. in four hours, and an average 4-hour potential of about 250 bbl.

After low fluid levels and lack of gas make the gas-lift uneconomical mechanical lift is applied. Three systems are in use. The Hughes plunger lift is really the next stage after gas-lift using gas energy for production. This equipment consists essentially of a string of special smooth bore tubing in which an all metal plunger travels the entire distance from top to bottom of the tubing and back to the top of each stroke, lifting the column of fluid above the plunger by gas pressure. The gas energy used is either derived from gas associated with oil, or is supplied from gas plants where required. The plunger fits the tubing fairly loosely, with a clearance of about .005-inch, and it falls by gravity alone. The oil is produced in short heads of around 2 bbl. per stroke, there being 4 to 7 strokes per hour. Production range is from 25 bbl. to 350 bbl. per day in a 2½ inch tubing, and up to 1,200 bbl. in 4-inch tubing. The gas pressure necessary to operate the Hughes plunger lift is independent of depth of the well and dependent upon the height of the column of fluid picked up by the plunger on each trip, which averages 200 to 300 ft. About 500 cu. ft. of gas per barrel of oil per 1,000-ft. lift are required. On a typical Oklahoma City well with tubing set at around 4,800 ft., the falling time of the plunger is 10.8 minutes, the rising and discharge time is 8.7 minutes, casing pressure is 185 lbs., production per cycle 2.4 bbl., per hour 7.4 bbl., and per day 173.5 bbl. with a gas input gas-oil ratio of 1,150 cu. ft. per barrel (9.2 cents per barrel at 8 cents per 1,000 cu. ft. of gas). The Hughes plunger lift is a distinct addition to mechanical producing methods and will be used extensively. Its drawbacks are the necessity of using compressed gas and apparent inability to handle large volumes of fluid, which is necessary in case of salt water encroachment. The cost of installation, including tubing, is around $5,500 for 2½-inch tubing and around $9,000 for 4-inch. Lifting costs average from 8 to 12 cents per barrel, depending upon the volume and cost of input gas. About 45 wells in Oklahoma City pool are produced with plunger lifts.

Reda submergible electrical pumps are proving fairly satisfactory in the Wilcox sand zone of Oklahoma City, lifting large volumes of oil and water. Total lifting costs are estimated at 1 cent per 1,000 ft. of lift, or at about 6 cents per barrel with pump and motor set at around 6,000 ft. The Reda pumps appear to be a solution for Wilcox sand production where large volumes of fluid will have to be lifted, and outside of its advantages in non-flooded areas, it may prove indispensable on edge leases where much water will have to be lifted; in these areas much greater recoveries may be anticipated. Seven Reda installations are operated in the Oklahoma City field at this time.

Pumping on the beam with sucker rods is applied to 103 wells in the Oklahoma City field. Sucker rod pumping in deep wells is an expensive method and averages in cost around 40 to 50 cents per barrel in

Oklahoma City at least. Sullivan heavy duty pneumatic pumping head with a 10-foot stroke has been found satisfactory. Complete pumping installations in Oklahoma City, which necessitates standardizing of the rig and cleaning out of wells, costs around $12,500 to $15,000 per well.

Inasmuch as operators of only a few wells each will find it difficult, if not impossible, to produce economically after wells discontinue producing on gas-lift, it is anticipated that many such operators will eventually combine their properties and will produce them under proper supervision and in a most efficient manner.

Cleaning Out Practice

ONE OF the most serious problems in Oklahoma City is that of cleaning out. As long as the pressures remained high, the oil carried with it to the separators loose sand from the producing horizon, while open hole above the sand was fairly well prevented from caving by the well pressures. But as soon as the bottom-hole pressures began their precipitate drop and the wells discontinued flowing, loose sand accumulated in the wells and the cavings began piling up from the open hole section. In Oklahoma City the situation was aggravated in the Simpson sand zone by interbedded caving shales and porous sands, while the Wilcox zone, composed of soft sand, caved badly itself. In addition the excessive open hole left by operators often exposed even the lower Pennsylvanian shale below the casing, and after being saturated with oil this shale almost flowed into the hole. As much as 2,000 ft. of cavings were found in Oklahoma City wells, although the average was around 200 ft. Originally cable tools with standard bailers were used in the field; subsequently the Cavins suctions bailers have been adopted and at this time a large percentage of cleaning out is done by the old air or gas pressure method patented by The Air Cleaning and Reaming Company of Tulsa. By this method air or gas under pressure of 400 lbs. is introduced into the well through tubing setting on top of cavings and it is ejected through a special jet-bit blowing the mixture of cavings, oil and water (introduced in the well if necessary) through the annular space between tubing and casing into the oil and gas separators. As the cavings are removed the tubing is lowered, a weight indicator being used to tell when the tubing is resting on cavings. Considerable increases in production of flowing wells has been observed, averaging about 60 percent, while cleaning out is imperative before mechanical lifting equipment is installed.

Cost and Profit of Development

THE TOTAL capital outlay for the drilling and equipment of 1,128 completed wells in Oklahoma City field has been to date $145,300,000. Combined estimated re-equipment of completed oil wells for gas-lift and pumping required to date an additional expenditure of $12,000,000. Cost of lifting oil recovered to November 1, 1934, is estimated at $32,700,000. Interest on capital invested is estimated at a minimum of $11,000,000, but more likely should be double that figure. Total expenditures to-date, therefore, have been $201,000,000. A grand total of 247,351,000 bbl. of oil has been produced to November 1, 1934, estimated to have brought gross about $226,270,000, allowing for greater than actual crude oil price, but discounting income from natural gas, or $191,500,000 net after deducting 1/8th royalty and 3 percent gross production tax. Oklahoma City field, therefore, as a whole has not yet returned the capital invested in it, falling $9,500,000 short, though the losses have been incurred only in Arbuckle sand and Simpson zones, where expenditures exceeded sales by $19,960,000. The Wilcox sand zone alone shows a net profit to date of $24,700,000. Estimated ultimate recoveries and future lifting and other costs, indicated earlier in this article, suggest that in final accounting Arbuckle and Simpson zones will reduce their net loss to $17,560,000, while the net profit from Wilcox sand wells will increase to $72,850,000. These figures may easily be improved if more rational production methods are adopted, even now in the Wilcox sand zone, more particularly if a smaller allowable is ordered at this time, which will go a long way towards improving conditions in the reservoir and increasing appreciably the ultimate recovery.

Indian Territory Illuminating Oil Company

ON AN ACREAGE basis the I.T.I. Oil Company is by far the leading operator in the Oklahoma City field. This company, prior to the discovery of the pool, leased some 6,000 acres on top of the structure, but with Wilcox sand production being developed from one to three miles away from the apex, I.T.I. Oil Company found most of its holdings within the less attractive Simpson and Arbuckle zones. The company completed a total of 360 producing wells, 84 in the Wilcox zone, 206 in the Simpson zone, and 70 in the Arbuckle zone; recovery to November 1, 1934, reached a total of 55,266,000 bbl. (153,500 bbl. per well); 18,295,000 bbl. from Wilcox, 27,250,000 bbl. from Simpson and 9,721,000 bbl. from Arbuckle. During October, 1934, the daily average gross production of the company was 28,730 bbl., 18,130 bbl. being derived from the Wilcox zone and 10,600 bbl. from the Simpson zone. The I.T.I. Oil Company is estimated to possess 21,000,000 bbl. of recoverable reserves, 11,000,000 bbl. in the Wilcox zone and 10,000,000 bbl. in the Simpson zone. Total expenditures of the company, including for future recovery, are estimated at around $68,000,000, including $6,000,000 interest on capital employed; total ultimate net income after deducting royalty interests and gross production tax, and allowing for $1.25 crude oil price for future production, is estimated at $65,200,000, thus at best the I.T.I. Oil Company will eventually balance the books in Oklahoma City development. Deficit on the development to date appears to be $17,000,000. The I.T.I. Oil Company as of November 30, 1933, owed to the parent company (Empire Gas and Fuel Company) $52,000,000, while its total outstanding A and B stock numbered 8,400,000 shares. Oklahoma City properties therefore do not exercise any positive influence on the capital structure of the I.T.I. Oil Company, any income to be derived in the future from Oklahoma City properties being destined to pay for past development.

Phillips Petroleum Company

PHILLIPS Petroleum Company has been extremely fortunate in its operations in Oklahoma City field. It acquired about 700 acres on the flanks of the structure, and most of it proved to be located within the richest section of the Wilcox sand zone. Phillips Petroleum Company completed a total of 123 producing wells, 115 in the Wilcox zone and 8 in the Simpson zone; recovery to November 1, 1934, reached a total of 36,560,000 bbl. (297,000 bbl. per well). During October, 1934, the daily average gross production of the company was 31,140 bbl. Phillips Petroleum Company is estimated to possess 27,000,000 bbl. of recoverable reserves. Total expenditures of the company, including for future recovery, are estimated at around $29,000,000, including $2,000,000 interest on capital employed; total net ultimate income after deducting royalty and gross production tax, and allowing for $1.25 crude oil price for future production, is estimated at $57,000,000, thus indicating a net profit for the company of $28,000,000 on the operations in the Oklahoma City field. Profit to date is indicated to be around $6,000,000.

The capital structure of the Phillips Petroleum Company roughly appears to be as follows at the end of 1934. About $26,000,000 of outstanding funded debt and about $8,000,000 of current liabilities

Table 6

Pipe Lines Out of Oklahoma City Field

Company	Size of Line in inches		Daily Capacity bbl.	October, 1934, daily runs bbl.
Standish (Phillips)	2–8		60,000	32,800
Cimmaron Valley (Champlin)	1–8		18,000	1,980
Continental	1–8		19,000	9,850
Empire	1–8		40,000	26,300
Magnolia (Socony-Vacuum)	1–8		26,000	19,300
Oklahoma (Carter-S.O.N.J.)	1–8		20,000	24,100
Sinclair-Prairie (Consolidated)	1–8	1–12	85,000	13,900
Stanolind (S.O. Indiana)	1–8	1–10	61,000	21,400
Shell Petroleum	1–8		12,200	3,760
Total			341,200	153,390

are balanced against $26,000,000 of current assets, including crude oil and other inventories at market: 4,154,687 shares of common stock are outstanding and quoted on The New York Stock Exchange at present at around $15 per share. Disregarding all other capital assets of the Phillips Petroleum Company, which are quite excellent, it is found that the Oklahoma City properties of the company are of outstanding value to the company's stockholders. The estimated total net income from Oklahoma City field exceeds the funded debt by $2,000,000, or is equal to $6.73 per share of the outstanding common stock of the company. Future net estimated income is equal to $5.28 per share of common stock, or to 35.2 percent of its current market value.

Carter Oil Company (S.O.N.J.)

CARTER Oil Company purchased on February 1, 1934, all properties of the Slick-Urschel, Inc., in Oklahoma City field. Properties acquired included 128 producing oil wells, 70 in the Wilcox zone and 54 in the Simpson zone, which to the date of sale produced about 23,325,000 bbl. of oil. Prior to the sale, Slick-Urschel, Inc. spent on drilling, development and production of its properties some $20,000,000, receiving net for the sale of crude produced about $18,000,000. The sale price, as reported in press, was $20,000,000, but probably did not exceed $5,000,000 to $7,000,000 cash, providing at the same time for certain royalty payments depending upon ultimate recoveries. The Carter Oil Company's reserves in Oklahoma City field are estimated at 15,500,000 bbl.; 13,000 bbl. in the Wilcox sand and 2,500,000 bbl. in the Simpson zone, after 5,000,000 bbl. recovery during the past year. The total all inclusive cost of recovering this oil is estimated at about $6,000,000, suggesting a net profit to the Carter Oil Company of around $15,000,000, in addition to having secured a large and valuable reserve of light crude oil for its parent company, the Standard Oil Company of New Jersey. In the vast and world-wide capitalization and assets of the S.O.N.J. the Oklahoma City properties are quite insignificant, but they still represent about 12.66 percent of the company's funded debt of some $190,000,000, or are equal to 60 cents per share of common stock. October, 1934, gross production of the Carter Oil Company in Oklahoma City pool was 18,410 bbl. per day.

Among other companies Sinclair-Prairie Oil Company (Consolidated) with 72 wells, 13,827,000 bbl. recovered to date, and 7,590 bbl. per day current production, and an estimated reserve of 3,500,000 bbl., is just recently in the clear on the development, and may ultimately come out with a $2,000,000 net profit; Skelly Oil Company with 23 wells, 5,992,000 bbl. recovered to date, 3,340 bbl. per day current production, and an estimated reserve of 2,750,000 bbl. may net $3,000,000, 17.65 percent of the company's funded debt, or $3 per share on its common stock.

Pipelines, Refineries and Markets

TWELVE trunk pipelines (10 8-inch, 1 10-inch, 1 12-inch) connect Oklahoma City field with the markets using its crude, principally in Oklahoma-Kansas, St. Louis and Chicago refining centers. Table 6 indicates operating pipelines, their capacities and current runs.

Seven independent refineries now operate in Oklahoma City field. Six of them are topping plants, while Black Gold Refining Company has a complete topping and cracking plant with a 3,500 bbl. capacity. Total daily capacity of seven operating refineries is 10,750 bbl., but actual October runs averaged but 2,753 bbl. per day, or 25.6 percent of capacity. In addition five topping plants are shut down.

Sixteen gasoline plants have been built in Oklahoma City field with a daily capacity of 636,000,000 cu. ft., producing, when operating to capacity, 363,000 gal. (8,640 bbl.) of gasoline. I.T.I. Oil Company operates eight plants with a total daily capacity of 280,000,000 cu. ft. of gas and 140,000 gal. of gasoline; Phillips Petroleum Company operates two plants with a total daily capacity of 210,000,000 cu. ft. of gas and 130,000 gal. of gasoline.

Geology—Stratigraphy

THE GEOLOGICAL section of Oklahoma City field comprises about 2,300 ft. of Permian and 3,900 ft. of Pennsylvanian sediments, before encountering the oil producing sands of Ordovician age or the Arbuckle limestone of Canadian age. Off structure an additional thickness of 800 ft. of Mississippian, Siluro-Devonian and Upper Ordovician sediments is present above the top of the Wilcox sand.

The Enid group of Permian is outcropping on the surface in Oklahoma City area, the Hennessey shale and the Garber sandstone being the members of the group in the immediate vicinity of the field. The older Garber sandstone forms an inlayer "peninsula" surrounded by younger

Table 7

Analysis of Typical Crude Oils from the Oklahoma City Field

	Wilcox Sand	Simpson Zone	Arbuckle Zone	Seminole Field Comparison
A.P.I. Gravity	40.0	38.4	37.6	39.6
Specific gravity	0.825	0.833	0.837	0.827
Sulphur content	0.16	0.19	0.16	0.33
Four Point	Below 5 deg. F	15 deg. F	10 deg. F	Below 5 deg. F
Saybolt Viscosity at 100 deg. F	40 sec.	44 sec.	46 sec.	39 sec.
Color	brownish-green	brownish-green	green	green
Gasoline and Naphtha content:				
percent	30.2	27.7	26.1	38.6
A.P.I. Gravity	62.3	61.0	60.2	61.0
Kerosene distillate: percent	16.8	16.2	16.8	4.9
A.P.I. Gravity	42.8	42.6	43.2	43.2
Gas Oil: percent	9.3	9.3	10.0	17.3
A.P.I. Gravity	35.8	35.4	37.8	36.4
Total Lubricating Distillate:				
Percent	19.8	20.2	18.7	15.7
A.P.I. Gravity	27.9 to 34.0	27.9 to 34.2	29.9 to 36.6	23.8 to 31.9
Residuum: percent	22.6	24.5	24.4	22.1
A.P.I. Gravity	21.3	20.7	21.6	16.2

sediments, a factor which contributed to the discovery of the field. The subsurface Permian sediments are quite similar to those encountered in the Lucien field (WORLD PETROLEUM—November 1934, page 422), though regionally they thicken by about 1,000 ft. in the southern direction, indicating an average thickening in Permian section of about 20.8 ft. per mile due south from Lucien.

The upper Pennsylvanian section in Oklahoma City field, considered here to the base of Pawhuska limestone series, is about 1,320 ft. in thickness, consisting principally of grey shales with few thin limestone and sandstone beds. Pawhuska limestone series show three distinct limestone beds aggregating 125 ft., and are the first reliable marker in the field.

The middle Pennsylvanian section on Oklahoma City structure is about 2,450 ft. thick; it consists of alternating shale and sand bodies, with three definite thick limestone markers, the Tonkawa, the Checkerboard and the Oölitic (first and second). The Checkerboard limestone is unusually uniform in thickness, averaging around 100 ft., and is the well established control point for structure mapping: it is a massive, grey-to-white finely crystalline limestone, easily recognizable in rotary cuttings. In the middle Pennsylvanian section there are seven distinct gas horizons and one secondary gas and oil horizon.

The lower Pennsylvanian section in Oklahoma City, from the top of Oswego limestone to the base of Pennsylvanian, is very thin, measuring but around 160 ft. This section consists of about 80 ft. of Oswego limestone and 80 to 100 ft. of Cherokee shales and sands. The Oswego varies in thickness from a few feet to 150 ft. and consists of grey and white, finely and coarsely crystalline limestones; fossiliferous, porous and gas bearing at base. The Cherokee shale section averages about 100 ft. and consists of dark grey micaceous shales and brown micaceous sands, with a few very thin brownish limestones. The more regularly occurring sand body within Cherokee section is known as "Prue" sand and it carries a large volume of gas and locally some oil. Table 8 gives the estimated production to date and reserves of the middle and lower Pennsylvanian sections (also refer to the geologic columnar section).

Table 8

Gas Production and Reserves of Middle and Lower Pennsylvanian in Oklahoma City

	Hoover	Endicott	Layton	Oölitic	Oswego-Prue	Total
Producing Area, acres	2,940	1,655	1,940	3,100	5,600	....
Wells Producing	2	....	17	13	49	81
Average Pay Thickness, ft.	21	20	25	18	28	....
Porosity, percent	12	10	18	12	13	....
Reservoir Pressure, lbs/sq. in.	1,670	1,675	1,820	2,055	2,315	....
Estimated Abandonment Well-head Pressure, lbs/sq. in.	126	127	128	130	132	....
Original Reserve, 1,000 millions cu. ft.	49.3	22.0	63.1	54.9	191.0	380.3
Original Recoverable Reserve, 50% Recovery, 1,000 millions, cu. ft.	24.6	11.0	31.5	27.5	95.5	190.1
Estimated Withdrawals to Nov. 1, 1934, 1,000 millions cu. ft.	2.0	....	4.0	9.0	35.0	50.0
Available Reserve, 1,000 millions cu. ft.	22.6	11.0	27.5	18.5	60.5	140.1

(in part from U. S. Bureau of Mines R. I. 3217, June, 1933)

As in the Lucien field, the Cherokee shale section is the basal member of Pennsylvanian beds; on the highest point of the structure, however, Cherokee has not been deposited, and Oswego is immediately above the unconformity. In Oklahoma City field locally 20 to 40 ft. of detrital material is found below Cherokee proper, principally along the downthrown side of the fault, and this section represents the earliest Pennsylvanian erosional phase; it produces small amounts of oil in the "Fault" zone, and also may develop small wells on the west flank of the structure, if ever tested.

In Oklahoma City folding and subsequent structural and erosional truncation entirely removed from the crest of the field about 25 ft. of Mississippi limestone, 80 ft. of Chattanooga shale (Mississippian); 350 ft. of Hunton limestone (Siluro-Devonian); 90 ft. of Sylvan shale; 40 ft. of Viola limestone, 1,000 ft. of Simpson sand series (Ordovician); and probably around 200 ft. of Arbuckle limestone (Canadian), or a total truncation of some 1,700 ft. of section.

The Simpson sand series of Ordovician account for about 95 percent of recoverable oil in the Oklahoma City field. Production in these sands is encountered on the flanks of the Arbuckle limestone core, with sands forming in effect lenses, sealed by overlying sediments of Pennsylvanian.

The upper Simpson limestone, about 250 ft. thick in its full section, consists of dense limestones and buff sugary dolomites, with thin sands and green shales in its lower 100 ft. The sandy dolomite just at the base of Simpson limestone section accounted for a cumulative production of 114,582 bbl. from two wells drilled by the Springrose Drilling Company in the southeast quarter of section 4, T. 11 N., R. 3 W., after these wells were plugged up from the Wilcox sand where they tested salt water.

The Wilcox sand, about 220 ft. thick in its full section, underlies the upper Simpson limestone and is the principal producing horizon in Oklahoma City accounting for 68 percent of the estimated ultimately recoverable reserves of the field. Wilcox sand is an unusually uniform producing formation, forming an ideal reservoir for oil accumulation which is entirely separated from the underlying lower Simpson sands. The principal body of Wilcox sand consists of grains of medium size, well rounded, very loosely bonded and remarkably free from all impurities. The upper 20 to 30 ft. of the Wilcox in the producing area of the field, where it is partially eroded, consists usually of green shales and bituminous residue; while the basal 10 to 20 ft. is represented by a mixture of dolomitic sands and green shales. The structurally highest portion of the Wilcox sand carries gas, while on the west side the original water level has been placed at about 5,425 ft. below sea-level. If the field had been produced correctly much greater ultimate recovery would have been possible from the Wilcox sand with combined forces of gas energy and water flushing under a pressure of around 2,600 lbs. As it is the gas energy has been criminally wasted, and water channelled deep into the field from the edges, due to areas of low pressure caused by locally close spacing of wells and resulting vast drainage. Thus, at this writing a large volume of water is produced in many Wilcox sand wells located very high structurally, due to intensified drainage in the northeast quarter of section 2, northwest quarter of section 3 and southeast quarter of section 22; this channelling greatly reducing the ultimate recovery by rendering the water drive ineffectively spotted and permanently sealing a large volume of oil within the sand.

The producing Wilcox sand section in Oklahoma City is estimated to be 120 ft. in its average thickness; a porosity of 25 percent or better, is indicated which would allow 1,950 bbl. of oil to be held per acre-foot of sand. Allowing for 80 percent saturation, 20 percent of sand filled by free gas and gas in solution, and a 75 percent recovery, which could have been achieved under ideal reservoir conditions and satisfactory producing practices, 411,800,000 bbl. of crude oil could have been recovered from the Wilcox sand in Oklahoma City field; 378,000,000 bbl. from

directly drained area, 3,365 acres, and 33,800,000 bbl. from the indirectly drained 1,000 acres within city limits, where drilling has been prohibited, calculating recovery from these 1,000 acres conservatively at 33.3 percent. Of the total estimated crude oil accumulation of 655,000,000 bbl. in the Wilcox zone (150,000 bbl. per acre), 62.80 percent could therefore have been recovered, but in actual fact under wasteful practices but 35.55 percent will be produced. That these figures are reasonably correct is further substantiated by the gas-oil ratios. Even if a fairly high gas-oil ratio of 2,500 cu. ft. per barrel of oil is allowed, 2,000 cu. ft. might have been possible, 411,800,000 bbl. would have required about 1,030,000,000,000 cu. ft., as compared with 1,026,000,000,000 cu. ft. blown out to produce 158,000,000 bbl. of oil recovered to date. All that would have been necessary for the maximum recovery from the Wilcox sand would have been: (1) setting last string of casing on an average 50 ft. into the sand; (2) production through 2½ and 3-inch tubing on chokes; (3) uniform rate of withdrawal per unit of area (acre) and per unit of time (day) to permit gradual encroachment of water; and (4) reasonable curtailment of production so that water level would keep up with the oil withdrawals. It is unnecessary to say that all these considerations were entirely disregarded in the past, and that even currently too much oil is produced from the Wilcox sand for maximum recovery under present reservoir conditions.

The Simpson below-Wilcox section of Ordovician, 565 ft. in thickness, is second in importance in Oklahoma City field. It includes the following producing horizons: —"Green Shale," School Land, Hammer-Haindland Kinter-Johnson sandstones and Stamper sandy dolomite. The cumulative sand section in lower Simpson is about 200 ft. of highly irregular sands, with possibly a total of not over 100 ft. well saturated. The sands are poorly assorted, intermixed with green shales and are tightly cemented in part with dolomitic matrix. Only the Kinter-Johnson sand carries edge water in volume sufficient for water drive, all other sands carrying apparently but very little water. Consequently after the gas energy has been wasted into the air, production of oil from lower Simpson sands is a difficult problem, but little oil seeping into the wells, while green shales cave into the open holes freely. Total recovery to date of some 70,000,000 bbl. is estimated to have taken about 426,000,000,000 cu. ft. of gas, and currently there is practically no gas left in the lower Simpson zone. On this basis and allowing as much as 3,000 cu. ft. per barrel of oil lifted 142,000,000 bbl. could have been produced ultimately from the lower Simpson sands, instead of the currently estimated ultimate recovery of about 91,000,000 bbl. It is probably impossible to calculate lower Simpson sand oil reserves on the basis of porosities and sand thicknesses as the conditions vary radically from well to well.

The Arbuckle limestone of Canadian, Ozarkian and upper Cambrian is estimated to be in Oklahoma City field around 2,000 ft. in thickness. It consists of sugary very finely crystalline buff dolomites with locally a slight admixture of green shale and sand in its upper 250 ft. Oil production was encountered principally 250 ft. below the top of the section and as much as 500 ft. in it. Arbuckle limestone recovered to date 17,837,000 bbl. of crude oil, higher recovery, up to 25,000,000 bbl. might have been possible with restricted production which would have delayed water encroachment.

Geologic History and Structure

THE OKLAHOMA CITY field appears to be the southernmost anticline of the "Nemaha" granite ridge extending from Kansas and including such important oil pools as El Dorado, Blackwell, Garber, Marshall, Crescent and Edmond. It is barely possible that the ridge continues further south in an echelon manner, but such extension has not yet been found.

The structure of Oklahoma City field is a very sharp faulted and truncated anticline. The history of this fold and its truncation dates back to Pre-Cambrian, though it was probably not till post-Hunton time that Oklahoma City anticline became an appreciable structural feature.

The earliest period of deposition, from the upper section of Arbuckle limestone, Canadian, to the basal Simpson, Ordovician, was almost continuous and no important unconformities have been noted near the Arbuckle-Simpson contact. The oil produced from the Arbuckle evidently originated within it, as is substantiated in part by the presence of numerous remains of organic life: also finding of production as much as 600 ft. in the Arbuckle precludes the possibility of its origin in younger sediments. The Simpson section has been deposited in shallow seas, possibly with frequent emergence and submergence, as several secondary unconformities within Simpson indicate. As in the Lucien field bituminous oxidized residues are found throughout the Oklahoma City field in or immediately above the Simpson group and this factor definitely indicates that oil originated at the time of Simpson deposition. During late Ordovician the upper Simpson limestones and dolomites and the Viola limestone were deposited in deep seas, followed by Sylvan shale and Hunton limestone. At the close of Hunton time there was a general emergence and subsequent erosion of land mass in northeastern Oklahoma, which but slightly affected the Oklahoma City region. The Oklahoma City area was further elevated at this time, so that the Mississippian sedimentation was slight, not exceeding 100 ft. The movement and faulting of the Oklahoma City structure probably began very gradually while Mississippian limestone was still being deposited, because its thickness immediately east of the fault is, if anything, greater than normal regionally. After the Mississippian deposition the Oklahoma City structure was sharply folded, faulted and truncated, the three processes taking place concurrently. The downthrown side of the fault sank but little while the upthrown side was rising during this period. By the time Pennsylvanian Cherokee seas submerged the Central Oklahoma peneplane the Oklahoma City structure showed around 2,400 ft. of vertical movement; 1,700 ft. of erosion from its apex, including Mississippian, Siluro-Devonian and Ordovician sediments and some 200 ft. of Canadian; and a 200-foot fault scarp, as suggested by the comparable thickening of the Cherokee section on the downthrown side of the fault. The erosion of Simpson beds naturally exposed the already oil saturated sands, but asphalt forming at the outcrops sealed the oil now remaining in the section, though undoubtedly a very large volume of oil, if not the larger proportion of it, escaped.

The advancing Pennsylvanian seas entirely submerged the Oklahoma City anticline only during early Oswego time. The movement along the fault gradually subsided during Pennsylvanian time, though probably it continued with diminishing intensity into Permian. The outstanding factor during that time was the sinking of the sediments on the downthrown side of the fault, probably due to the accumulated weight of Pennsylvanian beds, and to the weakness of as yet unstabilized basement complex. This sinking increased the height of the fault scarp from 200 ft. at the beginning of Cherokee time to some 600 ft. at present time, as is indicated on Figure 1.

The deposition of younger Pennsylvanian and Permian sediments gradually softened the structural relief of the Oklahoma City anticline: thus while on base of Pennsylvanian at about 6,000 ft. there is about 500 ft. of closure; this closure is decreased to 400 ft. on the Checkerboard limestone at about 5,100 ft.; to 250 ft. on the Pawhuska limestone at about 3,200 ft.; and to 100 ft. on the Garber sandstone

which outcrops on the surface. At the same time the axis of the fold gradually shifted fully one mile westward, as is shown on the insert of the structure map.

Conclusions

OKLAHOMA CITY field with its recovery to date of nearly 250,000,000 bbl., and a recoverable reserve of some 95,000,000 bbl. is an outstanding field of the Mid-Continent. In 1931 Oklahoma City field produced 46,337,000 bbl. or 24.55 percent of Oklahoma's total production in that year; in 1932 the field accounted for 22.05 percent of the state's total, producing 33,807,000 bbl.; and the corresponding figures for 1933 were 37.45 percent and 68,312,000 bbl.; while 1934 estimated production will be about 60,000,000 bbl. or 35.2 percent of the state's total.

Oklahoma City field was developed and produced in a highly wasteful manner. The field was overdrilled in its richest pay horizon, the Wilcox sand, and subsequently gas was wasted and water was drawn into wells very high structurally. The waste of capital due to unnecessary drilling can be approximately estimated at $32,500,000; but the waste due to practically criminal producing practices will be many times that figure. Considering that some 230,000,000 bbl. of crude oil could have been recovered ultimately in excess of what will be eventually recovered under past and present methods of handling the field, and considering that most of this oil could have been recovered by flowing or on gas-lift at a maximum cost of around 20 cents per barrel, and figuring on $1.00 crude oil, the operators of the field reduced their income by some $156,000,000, at the same time cutting the income of land and royalty owners in the field by $28,700,000 and that of state by $6,900,000. A total waste in excess of $200,000,000 is thus indicated, and while this figure may be somewhat too high, nevertheless it poignantly calls attention to the great waste in oil fields developed as wastefully as Oklahoma City was. Considering the definite limitations of the crude oil reserves of United States it is evident that the state and federal government can not and should not allow in the future a comparable waste of a vital and non-replaceable natural resource.

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Belgium Slows Action on Refinery Expansion

BRUSSELS, BELGIUM. DEC. 3.

WHILE it has been published abroad from time to time that Belgium would establish a monopoly of petroleum or at least would demand that the requirements of the Belgian market be domestically refined, the fact is that there has been no strong sentiment in support of either of these proposals. Of course, there are always politicians who can see personal or party advantage in undertakings of this sort and who find it useful to agitate such proposals in the absence of real issues.

Certain recent developments indicate rather clearly that the tide is not setting in the direction of a public monopoly or even the compulsory refining of petroleum within the country, inasmuch as preferential rates have been reduced and temporarily suspended. As a protection to the domestic refining industry the import duty on motor spirit originally was placed 46 centimes per litre higher than the excise tax on motor spirit and 32.5 centimes higher in the case of kerosene.

In a report submitted to the King by the Ministry at the beginning of November, the opening sentence is: "It appears necessary to bring about certain changes in the regulations governing the taxes on refined mineral oils in the country, this in order not to affect dangerously customs duties and excise tax on said oils which constitute one of the biggest sources of supply of the Treasury". In accordance with this recommendation a decree issued on November 4, reduces the tax differential on motor fuel to 30 centimes per litre and on kerosene to 20 centimes. At the same time the quantity on which domestic protection is to be allowed is limited to 50,000,000 litres which is roughly one-tenth of the total consumption.

Proration of the 50,000,000 litres assigned to domestic refining companies was left to the Minister of Finance but apparently it has presented some difficulties and at the end of November it was announced that the excise tax on manufactured products would be maintained at the same level as the customs duty on imports until proration orders were published. As to when that would occur no announcement was made. It is reported, however, that a new and more sweeping decree will be issued designed to eliminate unfair business practices. If such a measure actually is put in force it will effect an important and much needed change in the situation.

Whenever the proration order is issued it is expected that the major share of domestic production will be allotted to Belgo Petroleum Company which is jointly owned by Royal Dutch Shell, Anglo-Persian, Standard Oil Company of New Jersey, Texas Company, Atlantic Refining Co. and Purfina. Next in importance comes British Lianosoff, control of which has now been transferred from German to Belgian ownership. Royal Dutch Shell recently has completed a refinery on its property near Ghent which presumably will entitle it to an additional quota and there are a number of local interests with proposals that are contingent on their obtaining an allotment.

From the course of recent events it appears, however, that practical considerations of revenue are impelling the government authorities to go slow in encouraging the expansion of domestic refining.

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Oil in Africa

IT IS announced from Paris that the commission entrusted with a search for oil in French Equatorial Africa has obtained encouraging results in the district south of Gabon and east of Fernand-Vaz lake. A large lake of asphalt has been discovered, and the leader of the expedition is confident that oil deposits have been located that will exceed those of Morocco in importance.

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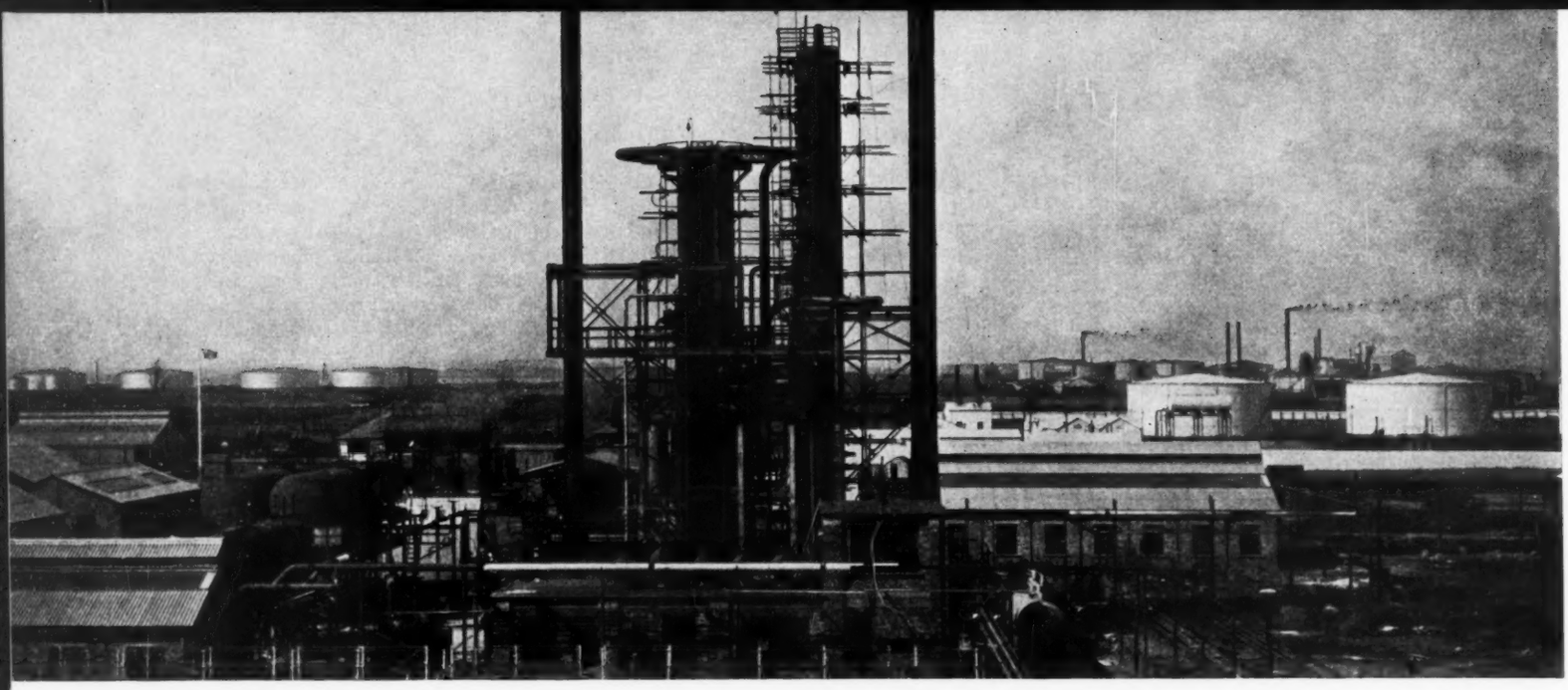
THE first of the giant new Clipper ships of the Pan American Airways, the Brazilian Clipper has recently completed its first run from Buenos Aires to New York in five days.



Lobitos Oilfields refinery at Ellesmere Port.

Lobitos Refinery Opened in England

A Third Step in the Building Up of An Important Fully Integrated British Oil Company is Accomplished With the Formal Opening of the Ellesmere Plant Processing 2,200 bbl. Daily of Lobitos Crude

COMPLETING one more link in the chain that makes a fully integrated oil company, Lobitos Oilfields Ltd. held the formal opening of its new refinery at Ellesmere Port on the Manchester Ship Canal, England, on Wednesday, October 24.

The Ellesmere plant itself embodies the remarkable advances in petroleum refining technology which have characterized this branch of the industry. It is designed to handle 2,200 bbl. of Peruvian and Ecuadorian crude from the fields of the Lobitos company to obtain benzine, kerosene and gas oil from the first or atmospheric stage which in turn provides charging stock to the second or vacuum stage to yield a complete range of lubricating distillates.

Lobitos Oilfields Ltd., under the chairmanship of the late Lord Forres, was formed in 1908 to exploit oilfields in Peru that had been proved for production by Alexander Milne. Later, additional areas were acquired in Ecuador and at present the company holds 205 square miles in Peru with 552 producing wells and 150 square miles with 391 producing wells in Ecuador. Low cold-test crude, high gravity and of low sulphur content is produced from both fields.

Formerly much of this crude was imported into the United States where it was refined and reshipped to England and other markets. With the establishment of the United States tariff on crude and oil products, the Lobitos arranged to ship its production to England and elsewhere. Now, the installation of the new Ellesmere plant enables Lobitos to process its oil directly in the company's refining unit.

As a second step in building up a fully integrated oil company, Lobitos acquired a fleet of five tankers for crude transport from South America. Four of these tankers were built by Sir W. G. Armstrong, Whitworth and Company, three of 11,012, 11,025 and 11,034 tons respectively and the fourth of 8,968 tons. The fifth tanker of 12,455 tons was built by the Blythwood Shipbuilding Company Ltd.

The final link was the erection of the Ellesmere Port Refinery under the supervision of Harold Moore. The engineering plans for the process units were prepared by Alco Products Incorporated of New York. The atmospheric stage is the Stratford oil circulation type of unit based on designs originally developed by the Stratford Engineering Corporation. The vacuum stage is a standard Alco type of unit which has been used in some of the largest vacuum installations in the world, such as the Alco installation at Baku, U.S.S.R. The entire process installation was handled by Alco Products International, the equipment being fabricated by Babcock & Wilcox Limited. The refinery will supply the wholesale trade in England and offers the benefit of a steady and reliable supply of a wide range of quality products.

In keeping with plans of the company, the new refinery embodies the latest developments for the fractional distillation of low cold-test crude to furnish a complete range of products suited to the British market requirements. The conditions called for an economical and flexible unit and after a careful study of the problem it was decided that a two stage unit would be the solution.

The successful development and the application of the Stratford oil circulation type of distilling unit in the Ellesmere refinery makes it of particular interest. Briefly, the apparatus consists of vapor-crude heat exchangers, settling tank, Stratford oil circulation heater,

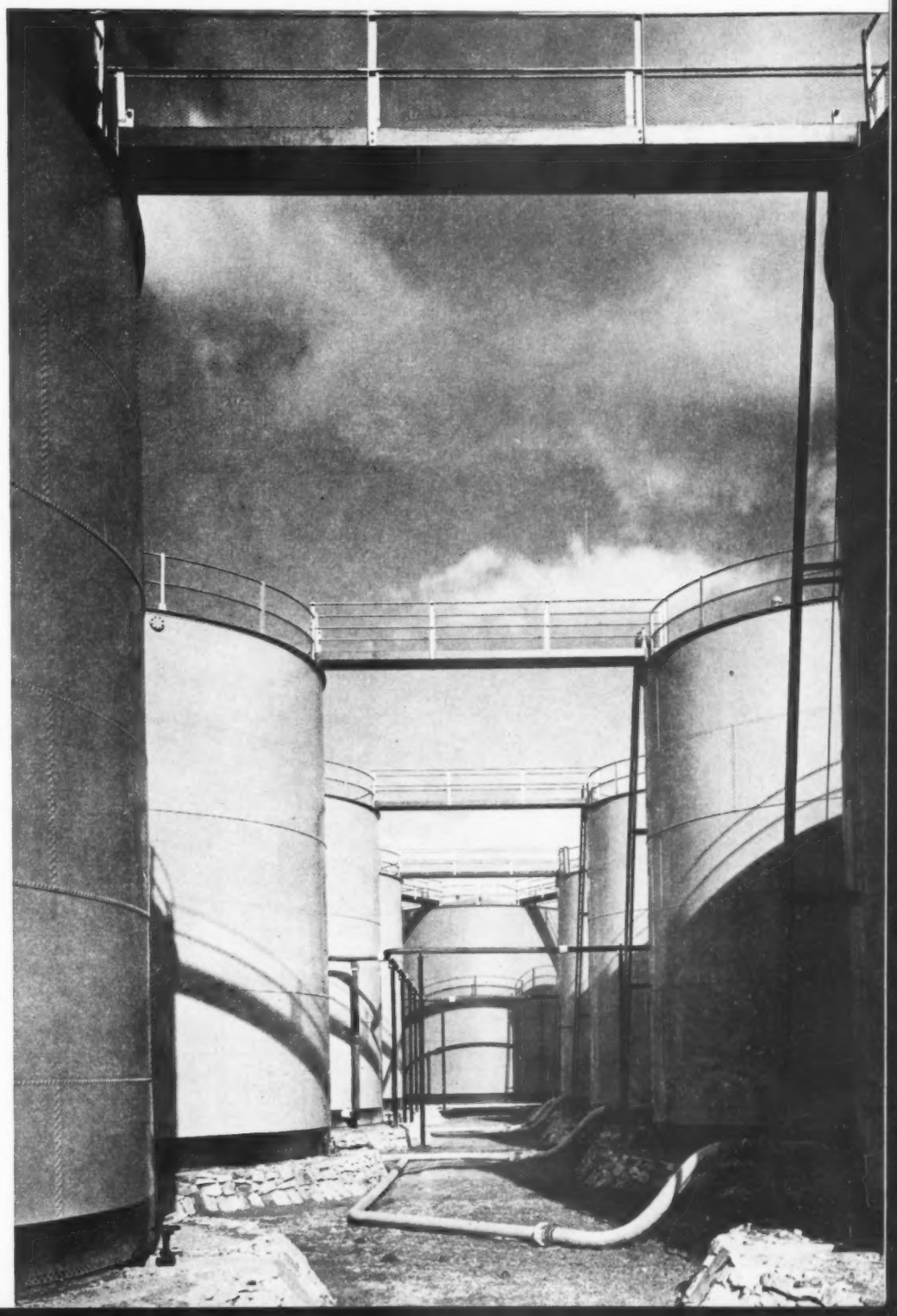
vaporizing tower, fractionation tower comprising three independent sections, reboilers and distillate receivers. The vacuum stage comprises an Alco type still of the most modern design providing a convection and radiant section, bubble tower fractionator with the respective stripping towers for each distillate, an Elliot multi-stage steam ejector in combination with an Elliot barometric condenser which is equipped with a mist extractor to overcome any entrainment of oil with the process steam, coolers and run down tanks. In addition both units have a centralized remote control and indicating equipment to require the minimum of operators.

The operation of this modern distilling unit is very interesting. The Stratford still was originally developed at the Avon, California refinery of the Associated Oil Company and was the outgrowth of modifications of the shell type still. Its successful application in Roumania and present installation in the Ellesmere Port plant, which embodies the latest improvements, mark a further development. Though, as mentioned, the still has a rated capacity of 2,200 bbl. per day, nevertheless it is extremely flexible and permits throughput rates one half or twice this rating without affecting the quality of the products nor facility of operation.

The Stratford heater, unlike the conventional pipe heaters, overcomes the installation of expensive masonry and it replaces and eliminates the residual heat and lends itself to quick firing and on stream use with high heat transfer rates. The design of the distillation unit is a system in conjunction with this heater whereby the reduced crude is utilized as a heat carrying vehicle from the heater to a reservoir, then to reboilers located on the fractionating tower. To carry out this operation the reduced crude, obtained by the benzine topping operation, is circulated from the reservoir to the heater and returned thereto and by means of direct oil heat interchange and reboiling of the fractions an unusually efficient distillation is obtained. The results tend to disprove the contention of refinery engineers that to obtain maximum yields of distillates the initial boiling point of one fraction should equal the endpoint of the previous one. In this installation by proper reboiling gaps as high as 21 degrees C. between fractions have been attained. Moreover, yields show an excess of 3 percent by volume, based on crude, over those obtained in the laboratory by modern and efficient equipment and procedure and as much as 6 percent by volume, based on the charge to the unit, over the well known Hempel distillation analysis.

A brief description of the flow and details of the particular apparatus is as follows: Crude is charged by means of a multi-stage centrifugal pump under 210 lbs. per sq. in. discharge pressure and is controlled by a Foxboro Stabilog system which is indispensable for uniform and precise operation. The crude charge passes through two vapor-crude exchangers located on the vapor lines of the benzine and kerosene distillates respectively, then through another heat exchanger on the gas oil line and when the unit is starting up a steam preheater is utilized before the crude is discharged into the horizontal settling tank. The oil is thus preheated to about 125 degrees C. and a complete separation of water and impurities is effected in this drum. The oil is withdrawn and passes next through the convection section of the Stratford heater. This apparatus is the essence of the entire system. The heater comprises a radiant section which is composed of a 12 foot long by a 4 foot diameter corrugated horizontal firing tube at the extremity of which is located the convection section tubes placed vertically and equipped with return bends, an air preheater and then flue stack connection

Whessoe tanks for spindle, engine and fuel oils at the new Lobitos refinery at Ellesmere Port, England.



follow. Combustion is maintained by a Peabody mechanical atomizing burner to which the preheated air is supplied at a temperature of approximately 320 degrees C. and under a fan pressure of 8 inches of water equivalent. An increased flame temperature results from the introduction of the preheated air and is a factor in giving the unit wide flexibility of throughput and varying rates.

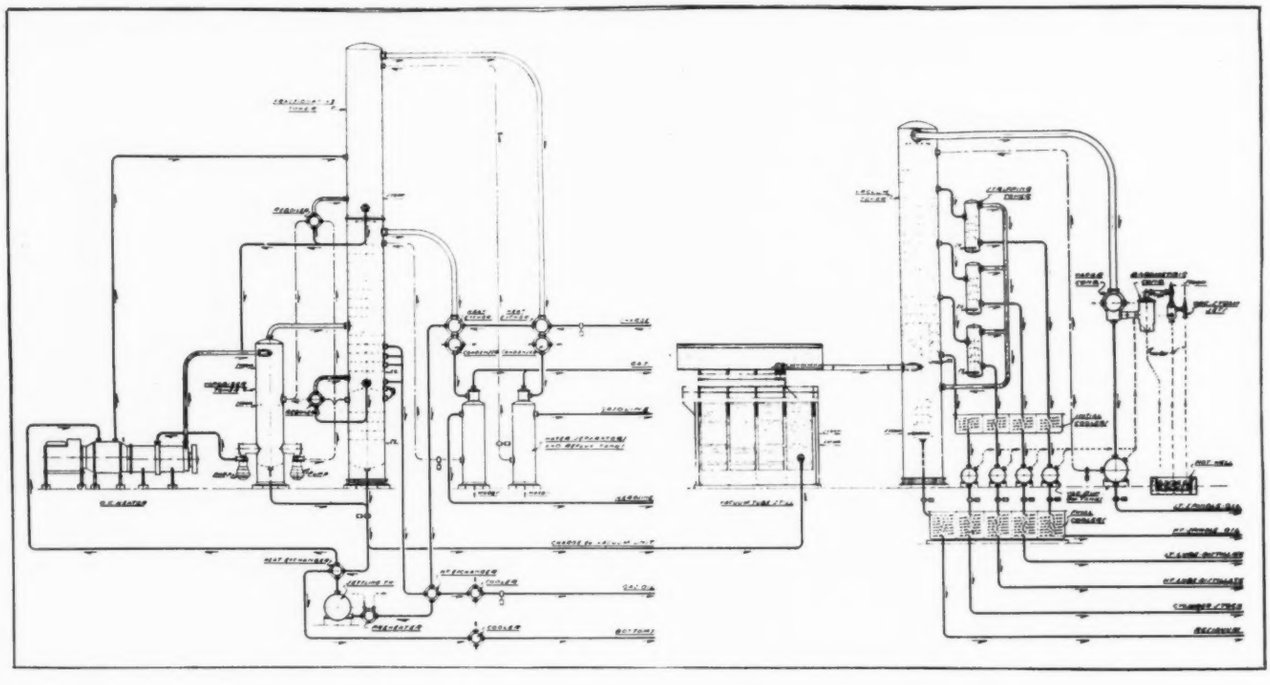
The crude charge passing through the tubular convection section is raised to 160–195 degrees C., depending on the operation rates, which vaporizes the benzine components and the product is delivered to the first independent section of the main tower or No. 1. Benzine of aviation distillation range and 140 degrees C. endpoint to normal motor spirit of 200 degree C. endpoint are taken overhead from this tower, as desired. The endpoint is automatically controlled by a Leeds and Northrup pyrometer of the electric anticipatory type. Accurate and flexible tower temperature control, to within one degree plus or minus, is obtained. From the base of tower No. 1 the reduced crude flows by gravity to the inlet line from the radiant section of the heater to the vaporizer or tower No. 2. This tower is the central reservoir for the reduced crude and provides the circulating oil to the radiant section of the heater and the heater oil for carrying out the reboiling operations, alluded to later. The tower is provided at its base with a horizontal perforated tube, connections extend without and at each extremity a vertical single-stage Byron-Jackson centrifugal pump is attached. One of these pumps, of 3000 gallons per minute capacity at 3 atmospheres discharge pressure, is used for the circulation of the oil to and from the radiant section of the heater. The other pump is for carrying out the reboiling operations which insure maximum yield. A Foxboro Stabilog system maintains the liquid level in this tower, No. 2.

As mentioned previously the Stratford heater comprises a radiant and convection section. Only reduced crude is delivered to the radiant section and this offers an unusual advantage since the circulating oil operation is entirely independent of crude charging rates and may be maintained constant. A detailed account of the radiant section merits consideration at this point. As described before, the radiant section is 12 feet long by 4 feet diameter. Encasing this tube is another, provided with nozzles, located at right angles to the corrugated surface of the first firing tube, which direct the circulation oil and a third manifold which forms part of the inlet oil conduit. The oil issuing from the nozzles at about 100 feet per second travels toward the firing end of the heater distributing itself as a sheet on the corrugated tube and the film temperature is maintained within a few degrees of the temperature of the main body of oil. The inlet and outlet difference is less than 5 degrees C. and no vaporization takes place here. High transfer rates, as high as 85,000 B.T.U. per square foot of heating surface, are obtained.

Inasmuch as the transfer rate of radiant heat varies directly as the fourth power of the temperature difference, a high rate of radiant heat transfer may be attained by rapid circulation of oil in this section and thus provide means of maintaining the temperature difference.

The circulated reduced crude travels from the reservoir, tower No. 2, to the radiant section and leaves the firing end of the heater and then commingling with the flow from the base of tower No. 1 the flow proceeds to the top of the vaporizing tower No. 2 where a spiral centrifugal head is located. The reduced crude from tower No. 1 vaporizes due to this heating medium. Inasmuch as the proportion of circulated oil to reduced crude is in the ratio of 50 to 1 it provides the necessary heat for the further distillation of the reduced crude. The vapors issuing from the vaporizer from the result of this action are then led overhead to the second independent section of the main tower or No. 3, just below the rectifying and above the stripping plates.

Conditions of operation of the vaporizing tower are such that equilibrium between the vapor and liquid phases are very closely attained. From this an advantage results since lower distilling temperatures are possible and thus the corrosive range of 280 to 320 degrees C. of normal pipe still operation is avoided.



Flow chart of the Ellesmere Port refinery in England.

By reducing the partial pressure with a small amount of steam in the vaporizing chamber, crudes may be 55 percent vaporized at a maximum temperature of 250 degrees C. and thus kept below the corrosive limit of 260 degrees C.

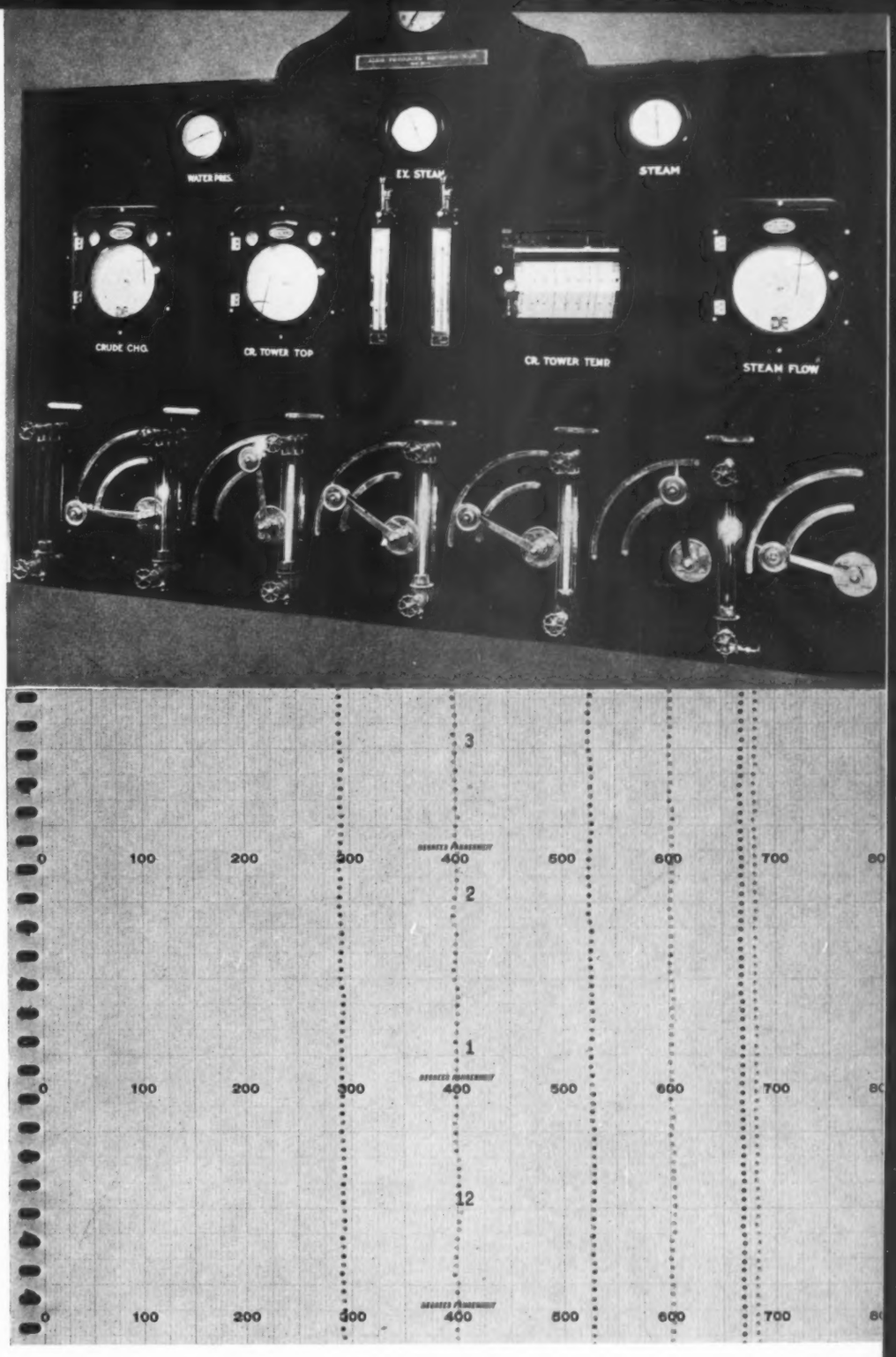
From tower No. 3 kerosene distillate is obtained of 270–300 degree C. endpoint and gas oil distillate from the stripping section in the lower part of the tower.

To insure maximum yields and control the products to specifications, both tower No. 1 and No. 3 are provided with thermo-syphon reboilers. The heating medium is the reduced crude maintained in the vaporizer and circulated, by one of the vertical pumps mentioned, to both of these reboilers. The oil circulated in no way affects the liquid level in the reservoir chamber. The base of tower No. 3 refluxes to the lowest of the main tower or No. 4. Steam introduced here passes upward and furnishes both No. 3 and No. 4 added means to maintain clean fractionation. The bottoms from No. 4, stripped thoroughly of light components, constitutes the charging stock for the vacuum stage unit to be further reduced to obtain lubricants.

A Foxboro flow controller regulates the charge to the vacuum unit. The charge is heated in the convection and then radiant section and the heater is so designed as to produce minimum tube skin temperature to insure a high yield of the valuable lubricating fractions. The charge heated to transfer temperature of 413 degrees C. is delivered to the vacuum tower. Light spindle oil is removed from the top and on this vapor line the Elliot multi-stage steam ejector and barometric condenser for vacuum and condensation of process steam are located. A noteworthy feature of this apparatus is the mist extractor to remove entrained oil and condensed product and its efficiency is such that practically no oil is carried to the hot well. The process steam is derived from the exhaust of the pumps and superheated in the pipe heater. The increased cross sectional area of the path of flow through the heating coil permits maximum vaporization to take place within the tubes where latent heat can be supplied by direct fire, instead of from sensible heat in the flash chamber, thereby insuring the lowest possible outlet temperature for a given precentage of vaporization.

Analogous to the unusual features embodied in the distillation unit are the streamline bubble tray design and the central temperature indicating flow control system incorporated in the vacuum unit.

The Alco streamline bubble tray, in keeping with the trend of the times, is the application of dynamic principles to the flow of a fluid in a fractionating tower. The oil entering is evenly distributed to removable, liquid-tight fitting troughs, by a weir from a reservoir which maintains the liquid level in the tray. The design prevents the accumulation of a static body of liquid and channeling of the flow. The bubble caps which are adjustable in height, have a streamline design and besides assuring a uniform vapor distribution, under any operating conditions, offer



Instrument panel at the refinery showing the method of side stream control and a reproduction of the actual record sheet. When the manual controls are properly set, as in this case, note the minimum variation in side stream temperature.

a minimum pressure drop, both of which are so essential in the design of an efficient vacuum unit. The conditions of operation are perfectly flexible inasmuch as the adjustment of the bubble caps to any submergence, and the weirs to any flow lend a ready means of meeting special fractionating conditions. Besides the above features, simplicity of construction, accessibility for cleaning and repairs and elimination of most of the usual packed joints characterize this modern design.

The second distinctive feature incorporated in the vacuum unit is the Alco side stream remote control system which centralizes the recording and regulating equipment of the units under the supervision of a minimum number of operators.

Because the charge to the unit is from a low cold-test stock it is possible to obtain the lubricating fractions, of a boiling range of the finished product, directly from the tower. The Alco side stream control was applied to the four streams to achieve this end. Unlike the conventional practice of side stream regulation directly at the draw off points on the tower, this noteworthy improvement permits the operator to make all necessary adjustments, to meet changes in specifications of the side stream, directly on the main control board. As will be noted in the illustration the micrometer control valves mounted on the operating board with their respective gauge glasses show all streams as they pass to the run down tanks. These micrometer valves adjust the rate of withdrawal from the external stripping towers and the rate of flow from the main tower to these stripping sections is in turn regulated by a liquid level controller located at the base of the strippers. Therefore, by means of these, any change in the setting of the micrometer valve by the operator brings about a counter adjustment in the rate of side stream withdrawal from the main tower. Such counter adjustment is immediately reflected in the draw off point temperature, continuously recorded on the board and thereby provides the operator an indication as to tower conditions without necessity of leaving his post. The operation of this system has proven extremely successful which accounts for the efficiency of the unit.

The wide range of products, from aviation distillate to lubricants and asphalt residue, which the refinery produces, offers all market requirements and its capacity and great flexibility of operation will permit meeting all demands.

Many distinguished persons of the oil trade in England and elsewhere attended the opening which marked one of the most important events of the British oil industry in recent years.

List of British and American Manufacturers whose Equipment was used in the Lobitos Refinery

Alco Products, Inc.	General design and engineering of complete plant
Anderson, V. A., & Co.	Filters
Asbestos Engineering Products, Ltd.	Insulation; pipe threading machine
Audley Engineering Company, Ltd.	Valves
Babcock & Wilcox, Ltd.	Fabrication; heat exchangers, fractionating towers; gratings
Bain, Wm., & Co.	Steel buildings ar. l fencing
Barclay, Andrew, & Co., Ltd.	Steam storage locomotive
Blair, J. F., & Co.	Buildings, foundations and miscellaneous labor
Byron-Jackson Co.	Hot oil pump; crude oil pump; 4 benzine, kerosene, and white spirit pumps
Cape Asbestos Co., Ltd.	Lagging
Crane Co. (U. S. A.)	Valves
Danks (Oldbury), Ltd.	Boilers
Dennis, H. W., & Co., Ltd.	Valves
Dewrance & Co.	Valves
Elliott Company	Multi-stage steam jet ejectors and barometric condenser
Fairclough, Harry	Buildings, foundations and miscellaneous labor
Fisher Governor Company	Governors on fractionators and other equipment
Foster Brothers, Ltd.	Pipe erection and flanged joints
Foxboro Company, The	Stabilogs and Micromax recording instruments
General Electric Co., Inc.	Motors on Byron-Jackson pumps
General Electric Co., Ltd.	Electrical plant; controls and equipment
Gould, B. F.	Buildings, foundations and miscellaneous labor
Hall, J. P. & Co.	Pumps
Harvey, G. A., & Co., Ltd.	Agitators
Hills-McCanna Co.	Lubricators on Worthington pumps
Holden & Brooke, Ltd.	Pumps
Leeds and Northrup Co.	Pyrometer temperature control
Manlove, Alliott & Co., Ltd.	Filter presses
Mather and Platt, Ltd.	Pumps
Merryweather and Company	Fire fighting system
Minter, F. G., (Decorations), Ltd.	Painting of oil tanks
Moore and George	Laboratory instruments
Neill, Wm., and Son (St. Helens), Ltd.	Small tanks
Nobel Chemical Finishes, Ltd.	Tank pipeline and machinery finishes
Oxley Engineering Co. Ltd.	Tanks
Quimby Pump Co., Inc., The	Pumps
Reavell and Company, Ltd.	Compressors
Roberts	Drum filling and weighing machine
Shipton, E., and Co., Ltd.	Automatic telephones
Stewarts and Lloyds, Ltd.	Piping
Thompson, John (Dudley), Ltd.	Lead lining of agitators
Whessoe Foundry and Engineering Company, Ltd., The	Main storage tanks
Willcox, W. H., & Co., Ltd.	Jones-Willcox large hose
Worthington Pump and Machinery Corp.	12 pumps; hot oil pumps

World Petroleum Abstracts

Summaries of the Most Important Articles as Published in the Oil Press of the World Which Will be A Monthly Feature of World Petroleum.

By Dr. O. W. Wilcox

Petroleum Geology

ACREAGE AND SAND THICKNESS AS FACTORS IN PRORATION.—M. Albertson in OIL WEEKLY, vol. 75 (1934), No. 10, pp. 33–34.

If proration means the act of dividing or distributing something proportionally, then the basis on which distribution is made becomes of importance. In this paper the author regards proration on an acreage basis as the fairest and most equitable basis of prorating in the oil industry. Acreage allotment should be paired with uniform spacing of wells. Thickness of producing sand, if it can be determined with reasonable accuracy and at a reasonable cost, may also be included directly as a proration factor; or if this is not practicable, well potential or reservoir pressures may be taken as the equivalent of sand thickness.

MEASURING PERMEABILITY OF OIL SANDS.—F. B. Plummer, Sidon Harris and John Pedigo in PETROLEUM WORLD (Brit.), vol. 31 (1934), No. 410, pp. 283–286.

Using an apparatus designed by them at the University of Texas the authors determined the permeability of outcrop samples of Woodbine and Cisco oil sands with the view of clearing up some of the principles of such determinations. It was found that both linear and radial permeabilities were greatly increased by successive cleaning of the cores with distilled water and by air injected at rather high velocities. The result indicates that if the actual permeabilities of the semi-consolidated deposits as they exist in the subsurface are to be determined, excessive pressures of the gas or fluid should not be employed in the test. Data taken under conditions of high pressure and rapid flow lead to permeability values higher than those that actually exist in nature. Furthermore, the results of the tests described in this paper lead to a conclusion well known to oil operators, that the permeabilities of the sands adjacent to producing wells can be substantially increased by allowing the well to produce at a maximum rate for a time after it comes in, and the longer the time and the higher the rate of flow, the better. Radial permeability is appreciably less than linear permeability.

GEOLOGY AND UNIT OPERATION OF OIL AND GAS FIELDS.—C. Dwight Avery and J. Charles Miller, in BULL. AM. SOC. PETROLEUM GEOLOGISTS, vol. 18 (1934), No. 11, pp. 1454–1492.

The petroleum industry is now generally thinking of doing what should have been begun long ago, namely, operating oilfields as units. The industry is being more and more forced to consider this method by the well-known results of uncontrolled production, low prices and increasing production abroad. There are now six fields in the United States involving public lands that are under unit operation, namely, North and Middle Domes of Kettleman Hills in California; Little Buffalo Basin, Big Sand Draw, Billy Creek and Pitchfork fields in Wyoming. Plans for unit operation of the McCallum field in North Park, Colorado, are under consideration. The principles governing unit operation in these fields are two: each owner of the surface is entitled to receive his ratable share of oil and gas in the pool at time of discovery, and the pool should be developed so as to recover the maximum quantity of oil therefrom. Unit operation is justified by the economic results; exploration costs are lessened by restricted drilling, production expense is decreased, reservoir energy is conserved, ultimate recovery is increased and the life of the field is prolonged. If generally adopted unit operation would be the surest means of balancing supply and demand and insuring conservative development.

Unit operation of an oil field is essentially controlled by the geological structure of the field, which is for the petroleum geologist to determine, and it is also the function of the petroleum geologist to indicate how unit operation may best be put into effect. The authors describe the petroleum geology of each of the six fields above named and show how the unit plan was evolved.

It should be understood that upon request of parties interested in formulating a bona fide cooperative or unit plan, the area logically subject to unitization will be designated by the United States Geological Survey. Unitization may even precede discovery, as was the case with the South Dome of the Kettleman Hills, provision being made for subsequent designation of participating and nonparticipating acreage.

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Oil Well Operation

PROGRESS IN THE ART OF DRILLING IN ROUMANIA.—A. Pleniceanu in ANN. MINES ROUMANIE, vol. 17 (1934), No. 11, pp. 415–424.

The author sketches the progress of oil well drilling in Roumania since 1928, which has been characterized by a continual struggle to reduce costs so as to stay ahead of constantly falling oil prices. That the industry has been able to survive is largely due to the fact that drilling cost in 1934 has been reduced to 17 percent of the 1926 cost. Many of the improved methods in use have been imported from the United States, but there are several of native origin. One of these is the cementation process by which successive oil or water bearing formations may be sealed off and the well continued to the lowest oil horizon; when this stratum has been exhausted the overlying horizons are exploited in succession; this is called working from below up. Another Roumanian innovation is electrical

means of testing the resistivity and porosity of different strata encountered. In general modern methods and appliances are finding their way into the Roumanian oil regions, but there is a tendency to hold on to old equipment as long as possible.

Steam Power in Drilling.—W. Osenberg, in OEL UND KOHLE, vol. 2 (1934), No. 10, pp. 477–479.

For power purposes in oil well drilling the modern steam engine especially adapted for oilfield work has, according to Mr. Osenberg, a distinct advantage in economy over Diesel engines of the same rating, even in Germany where fuel costs are high. Comparison of a 200 h.p. steam engine with a Diesel of the same first cost, rating and total weight (10 tons) the fuel costs of the steam engine (using coal) are half, the water consumption a third, and lubricating oil consumption about a tenth of the corresponding items for a Diesel engine.

Rotary Hose Maintenance.—A. D. MacLochlan in OIL WEEKLY, vol. 75 (1934), No. 3, pp. 23–24.

The hose used to carry the drilling mud is one of the vital pieces of equipment in oil well drilling; it is subject to enormous strains in operation and is frequently mishandled when the rig is moved. The author points out one way by which the life of the hose may be lengthened. This is to have two hoses in the rig. The extra one is not suggested as a spare, but the idea is to use them alternately, so that while one is working the other may have an opportunity to dry out. It is stated that by this alternation it is possible to get much longer service from the two hoses than if the second hose were used only after the first has worn out. It is a fact that the rubber used in drilling hose absorbs water under the enormous pressure to which it is subjected and it is to allow removal of this water, which would otherwise promote deterioration, that the advice is given to have two hoses for periodical drying out.

Portable Rotary Deep Drilling Unit.—Gerald F. Benedict, in PETROLEUM ENGINEER, vol. 6 (1934), No. 1, pp. 23–24.

A portable rotary drilling rig that involves a minimum amount of time and expense in getting into action has been evolved by the Wilson Manufacturing Company and is now in successful operation in Western Kansas. It is designed for depths to 5,000 ft., using a 4-in. drill pipe. The entire outfit is so compact that it can be loaded on a 7½-ton truck and moved from place to place in one load. It is furnished with two 125 h.p. engines, one for driving the truck and the other for operations at the well, but when on location both engines can be operated separately or together to drive the rotary table, the draw works, or to operate the pump and the lighting equipment. Besides economy in cost of transporting the rig, there is economy in the speed and simplicity of rigging-up; drilling may be begun in four hours after arriving on the site. For exploratory work with small pipe (4-inch) the apparatus saves in water and fuel as well as time.

Acid-treating of Wells.—Frank H. Love, in PETROLEUM ENGINEER, vol. 6 (1934), pp. 32–35.

Interesting details are given of present practice of the acid-treatment of oil wells in Texas, Oklahoma, Kansas, New Mexico and Louisiana; in this region one company has treated more than 3,500 wells since September, 1932. The treating medium is usually a mixture of equal parts of commercial concentrated hydrochloric acid and water. Although subject to variation, the standard treatment is 1,000 gallons, which is pumped into the well and followed by crude oil from the crude stock tank on the lease in order to force the acid into the oil formation; the amount of this forcing oil depends on circumstances, chiefly whether the formation is a hard, tight dolomite or a porous limestone. In some instances as much as 200 lbs. pressure is required. It is desirable to put the acid in position as soon as possible to prevent its being neutralized before traveling the greatest possible distance from the bottom of the well, and to clear the acid from the well before it has time to act on the casing. The well is then shut down for 36 to 48 hours, after which it is opened up and again placed in production.

Special conditions sometimes call for special variations in technique. In very hard dolomitic limestone crude oil is first heated to a high temperature and forced down the tubing, past the producing formation and back up outside the casing; this is to heat up the casing and the formation. The acid is then heated in a special coil and injected into the heated system so that it reaches the spot without opportunity to cool off. On the other hand, in pure limestone areas where the tendency is for the acid to become neutralized before reaching as far as desired into the producing formation, the acid is cooled to a low temperature with ice so that it will be slow to act and thus will travel farther. Most old wells require no pressure to place the acid.

The amount of fluid required to treat a well varies, but in general the more acid used the more effective the treatment. In prorated fields, however, there will be no point in securing a yield much greater than the allotment, so that the majority of operators have agreed on 1,000 gal. as the average desirable quantity. Many wells have been treated more than once, but as a rule the first treatment results in a greater increase in production than succeeding ones.

Acid treatment is used not only for rejuvenating stripper wells, but almost as frequently for the bringing in of wells drilled into formations having no show of oil. An instance is given from near Graham, Texas, where a test hole resulted in no showing of oil; after treatment with 3,000 gal. of acid the well started flowing at 100 bbl. per hour and after six months is still good for several hundred bbl. a day. Fifty percent of tests in the active Archer County field that at first showed no oil have been made into 500 to 1,000 bbl. a day wells. Others have been converted from five bbl. to 1,200 bbl. daily.

Natural Gas

Internal Corrosion of Natural Gas Pipelines.—E. F. Schmidt and T. S. Bacon, in PIPE LINE NEWS, vol. 6 (1934), No. 12, pp. 6–8.

Distributors of fuel gas have had their troubles ever since the first gas pipeline was installed, and one of the chief of these difficulties is corrosion of the metal of the pipe; this corrosion occurs on both the inside and the outside. External corrosion can be obviated more or less easily by appropriate coatings, but internal corrosion is a different problem.

Internal corrosion of gas pipelines has various causes and consequences; the inside of the pipe may become pitted, resulting in leaks. Even if pitting does not proceed to the extent of perforation the internal surface of the pipe may be so roughened that the friction factor will be raised so far that the capacity of the line is reduced.

The causes of internal corrosion may be present in some lines and absent from others. There are some natural gas transmission lines that have been in service for

20 years without appreciable internal corrosion, while others have been put out of use in a few years by this cause. Natural gas itself, so long as it consists only of hydrocarbons, does not cause corrosion. According to the authors, in all reported cases of serious internal corrosion of gas pipelines oxygen has been present in the gas, but oxygen alone is unlikely to cause corrosion; it requires, among other things, the presence of water either as liquid or as partly saturated vapor; oxygen and water cause iron to rust. Besides oxygen, the presence of hydrogen sulphide will cause corrosion if water is present; in the absence of water hydrogen-sulphide has little or no effect on iron unless heated to about 400 deg. F., although it will act on copper or brass fittings at much lower temperatures. Carbon dioxide gas, although a weak acid, has probably little or no corrosive effect in this connection. The corrosive effect of water, oxygen and hydrogen is the greater the higher the pressure.

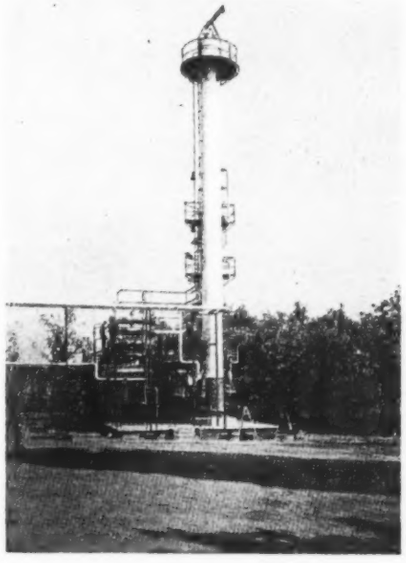
Another cause of corrosion of gas pipe lines has been found in districts where the oil wells have been treated with hydrochloric acid to enlarge production. This acid, being quite volatile and carrying more or less moisture may enter the gas lines and attack the metal with formation of iron chloride; or gas that is cleaned with water containing salt may entrain some of this water with similar results. In regions where the raw natural gas varies through a wide range of heat value some gas companies add nitrogen to stabilize the calorific value of the gas for distribution; if this nitrogen is obtained by burning some of the gas in air to remove the oxygen, nitrous oxides are formed which may cause serious corrosion.

The causes of internal corrosion being more or less well known there arises the question of preventive measures. These include protective coatings, which are receiving increasing attention. One company reports a reduction of 75 percent in the rate of corrosion by injecting a light oil into the compressor station discharge gases. Resistant alloys are as yet too expensive for pipeline use. Among other measures, complete dehydration of the gas seems to offer the best solution in most cases, especially in high pressure distributing systems; water and hydrogen sulphide may be effectively removed in this way. In many cases it is impossible to free the gas from oxygen, but this does not matter much if the dehydrators are really efficient.

Petroleum Refining

New Form of Oil Fractionating Tower.—Nickolaus Mayer, in OEL UND KOHLE, vol. 2 (1934), No. 10, pp. 479–482.

In the fractionating column of a topping plant the construction must be such as to make a clean separation of the gasoline, kerosene and gas oil fractions. The composition of the crude oil governs the number of bubble plates and the location of the draw-offs. If the positions of the draw-offs are fixed, the fractionation can be controlled by regulating the feed and the proportion of the reflux to the draw-off. Another usual expedient is to provide an arrangement so that the positions of the draw-offs can be shifted up or down the column. In the new topping plant designed for the Ersag refinery at Salzbergen, the column is equipped with both variable draw-offs and bleeders; by means of the latter, refluxing liquid can be withdrawn from a section and passed through auxiliary superheaters located on top of the pump house (see illustration). By this arrangement the tower operations are given an extreme flexibility; the number of bubble plates between the different fractions can be altered at will and the action of these plates can be completely controlled by means of the hot liquid that is drawn off through the bleeders, reheated and returned to the system, so that with a small number of plates and a large volume of reflux the same result may be obtained with a large number of plates and a small throughput. In the acceptance tests it was found possible to establish a 25 deg. C. spread between the gasoline and kerosene fractions, and a 10 deg. C. spread between the kerosene and gas oil fractions. The regulation of the column is largely automatic. The residue amounts to 10 to 12 percent. The outfit is considered of special interest because it demonstrates the possibility of obtaining lubricating oil from German crudes without employing a vacuum process.



Rearranging Refinery Equipment.—Allen M. Peairs in PETROLEUM ENGINEER, vol. 6 (1934), No. 1, p. 25.

This is a success story of how an 1,800 bbl. topping plant costing $75,000 and giving unsatisfactory results was converted into a successfully operating plant processing 5,500 bbl. of crude by an expenditure of no more than $25,000, which was spent chiefly for a new 30-tray bubble tower.

First Duo-Sol Process Unit in Operation.—Arch. L. Foster in NATIONAL PETROLEUM NEWS, vol. 26 (1934), No. 4, pp. 35–42.

This is a description of the construction and operation of the first commerical unit for oil refining by the Duo-Sol process, which depends on the selective solvent action of two solvents applied successively to the oil under treatment. The first solvent in this series is ortho-cresol, which removes the naphthenic components, and the second is liquid propane, which is a solvent and carrier for the more desirable paraffinic portion of the oil. The plant is located at Paulsboro, N. J., built by the Lummus Company and used by the Vacuum Oil Company for treating mid-continent and other stocks. The rated capacity is 3,000 bbl. daily.

The complete unit consists of three sections: the extraction battery, where the solvents are successively applied, one set of stills for recovering the cresol, and another set for recovering the propane. The operation consists in making a preliminary extraction to divide the stock roughly into paraffinic and naphthenic fractions; each of these fractions is then again treated with both solvents and so on until complete separation of the paraffins and naphthenes has been effected. The results obtained are regarded as quite satisfactory. Good results have been obtained even from San Joaquin distillate, which heretofore has not been regarded as a possible source of lubricants. Most of the treated oils show only a slightly lowered flash point and an increased gravity; carbon residues are very low. West Texas residuums high in

sulphur give lube oils of high color stability and the solvent-refined oils show far less tendency to form sludge than conventionally refined paraffinic oil.

Automatic Arc Welding for Pressure Vessels.—O. A. Tilton in WORLD PETROLEUM (1934), No. 12, pp. 462–464.

The author notes that there are still some engineers in the oil business who are loath to adopt welding in various constructions used in the industry. Such engineers miss both the convenience and the numerous opportunities for economy offered by the different forms of the welding process. Welding makes it possible to use pipe that is both stronger and lighter. In the refinery, high pressure and high temperature cracking-stills have increased production from the crude oil. Electrodes are now available for given specifications of steel, so that the welded joints may have the same tensile strength, yield point and ductility as the plate itself, as well as a grain structure such that corrosion is no greater than in the parent metal. Machines and electrodes have been developed for automatic welding in which variables incident to the human element are avoided, so that welded constructions are now thoroughly dependable.

Applications of the Film Concept in Petroleum Refining.—Carl C. Monrad, in INDUSTRIAL AND ENGINEERING CHEMISTRY, vol. 26 (1934), No. 10, pp. 1087–1093.

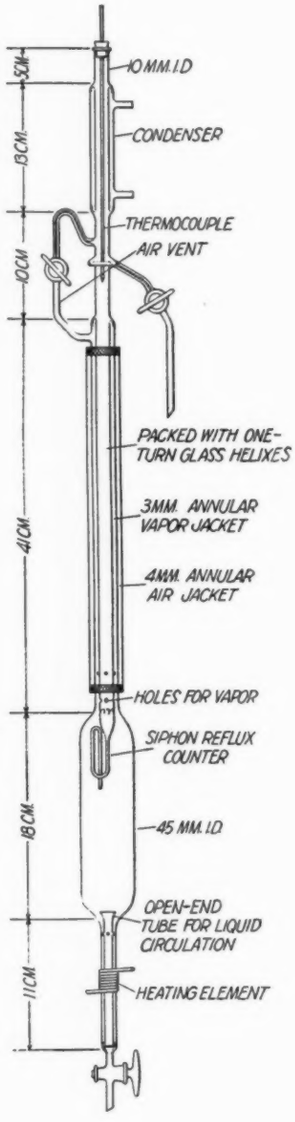
During the past few years it has become apparent that many supposedly complex problems in various process can be correlated by means of the concept of "stagnant" films.

Some of the applications of the film theory to the petroleum refining industry are reviewed in this article. In some cases the application is fairly simple—notably heat transfer and friction losses—but others of the more complex problems still have to be solved. Among these are, particularly, deviations from equilibrium in absorption and fractionating towers and evaporation losses from tankage.

An equation is developed for evaporation from large plane surfaces to flowing gases, based on heat transfer and diffusion data obtained by several investigators. Besides heat transfer, the use of the equation in investigating pressure drop, thermal decomposition, fractionation and absorption and various other contingencies in petroleum refining are exemplified.

Efficient Small-scale Fractionating Equipment.—C. O. Tongberg, D. Quiggle and M. R. Fenske, in INDUSTRIAL AND ENGINEERING CHEMISTRY, vol. 26 (1934), No. 11, pp. 1213–1217.

In the lighter petroleum products, such as gasoline, more efficient fractionation is desirable, particularly for making specialty products. Small-scale fractionating columns are not only useful as analytical apparatus but are also helpful



in the design and operation of large-scale equipment. While small columns can be made much more efficient than large ones, they usually lack the means of measuring and controlling the important operating variables—namely, rate of distillation and reflux ratio.

This control is possible with the two small columns designed by the authors, one of metal and the other of glass, the latter being shown in the accompanying illustration. These columns can give important information, as different mixtures are found to give different degrees of enrichment, so that they should be useful in anticipating the performance of larger packed columns. The rate of distillation and reflux ratio being known, they enable careful study to be made of batch fractionations.

Uses for Gases from Cracked Hydrocarbon-Oils.—Gustav Egloff and J. C. Morrell, in INDUSTRIAL AND ENGINEERING CHEMISTRY, vol. 26 (1934), No. 9, pp. 940–944.

The oil industry is developing more and more along the line of synthesis because of the enormous quantities of unsaturated hydrocarbons which it is producing from the cracking of gasolines, naphthas, kerosene, gas oils, fuel oils, and crude petroleum. These unsaturated hydrocarbons are present not only in the cracked products comprising gasoline, kerosene, and tractor, stove, furnace, Diesel, and fuel oils, and asphalt, but also in the gas produced. The volume of cracked gas now available yearly is over 300,000,000,000 cubic feet (8,400,000,000 cubic meters) averaging over 20 percent of unsaturated hydrocarbons with some exceeding 50 percent. The volume of cracked gasoline per year is 7,600,000,000 gallons (28,850,000,000 liters), which contains an average of about 20 percent of unsaturated hydrocarbons.

Cracked gases now form the basis of a synthetic chemical industry wherein a large number of compounds, having a wide variety of uses, are produced.

Chemically, the unsaturated hydrocarbons in cracked gases react readily to form many compounds useful as such, or as intermediates for making other products. The chlorides, such as ethylene dichloride, may be made without difficulty by simple addition. Hypochlorous acid reacts readily with olefins to form chlorohydrins which can be subsequently converted into glycols by hydrolysis. The formation of alcohols may be accomplished by absorption of olefins in cracked gases by sulfuric acid in the presence or absence of a catalyst followed by subsequent hydrolysis. Starting with the simple addition reactions, the whole field of aliphatic chemistry may be developed.

The following groups of compounds have been synthesized and produced commercially from cracked gases: alcohols, amines, chlorides, glycols, nitroglycols, chlorohydrins, ethers, ketones, acids, and esters.

Some of the outstanding uses for these products are as antifreeze agents (ethylene

glycol), explosives (nitroglycols), agents to remove hydrogen sulfide or carbon dioxide from gases (triethanolamine), solvents for lubricating oil treatment (dichloroethyl ether), medicinals (acetoacetanilide), fumigants (ethylene oxide), solvents for plastics and lacquers (alcohols, esters, ketones), resins, synthetic rubber, and others. It is reported that two hundred thousand tires were produced in Russia during 1933 from the polymerization of butadiene from cracked gases.

Petroleum Physics

Application of Thermodynamic Data to Petroleum Production Problems.—W. N. Lacey and B. H. Sage, in OIL AND GAS JOUR., vol. 33 (1934), No. 26, pp. 86–90.

During the whole series of steps involved in the production and transportation of petroleum products, the materials are constantly subjected to changes of temperature, pressure, elevation or velocity, and these changes may be gradual or abrupt. All such changes involve corresponding changes of energy and these energy changes take place in accordance with the laws of that branch of physics known as thermodynamics. This science is a more or less formidable study, but the efficient oil engineer must make use of it if he expects to accomplish results with the least trouble and expense. Such knowledge is of especial value in practical oil-field work in measuring and utilizing formation temperatures and pressures, the influence of production rates, for solving problems that arise in oil or gas transportation lines, and particularly for cases where artificial energy has to be supplied. Computations relating to these problems are facilitated by the charts and explanations furnished by the authors.

Present Position of Investigations on Lubrication.—V. Vieweg, in OEL UND KOHLE, vol. 2 (1934), No. 11, pp. 394–400.

The present position of research on lubrication is that no clear and definite way has yet been found for subjecting an oil to a preliminary examination and finding a figure that will measure its lubricating value, but at least progress is being made in that direction. Viscosity alone is not a guide, because two oils with the same viscosity will show different friction values. The same oil will show different results with different steels and alloys, so that evidently the properties of metals enter the problem as well as properties of the oils. The final solution will lie in a combination of methods, and the German Physikalisch-Technischen Reichsanstalt is working in that direction. Physical and chemical investigation has shown that the molecular force between the bounding surface and the lubricant determines the lubricating property of the oil. This molecular force can be measured by measuring the orienting effect of an electric current, which is determined by unipolar conductivity in a special electric circuit. This gives values which correlate with the results of measurements of friction and layer thickness. Further work remains to be done to see how far the method may be relied on for quantitative determinations. The author gives an excellent summary of the literature of this field.

Factors Affecting Lubricating Properties of a Petroleum Oil.—F. H. Rhodes and Arthur W. Lewis, in INDUSTRIAL AND ENGINEERING CHEMISTRY, vol. 26 (1934), No. 9, pp. 1011–1014.

The authors undertook the investigation here described with a twofold purpose: (1) to isolate and to identify the component that is primarily responsible for the "oiliness" of petroleum lubricants; and (2) to discover, if possible, other substances that, when added to an oil, will have a similar effect in improving the lubricating properties. The first of these problems has not yet been solved; the second objective has been attained, and new confirmation is found for the conclusion that the effect of a petroleum lubricant in reducing the static coefficient of friction in a bearing appears to be due primarily to the presence of a small amount of some substance that is firmly adsorbed on the surface of the bearing to form a film of high lubricating power. This film does not form instantly on a freshly oiled surface; an appreciable length of time elapses before equilibrium is established.

The constituent that is primarily responsible for the lubricating power may be removed from the oil by adsorption on finely divided metal—for example, on powdered Wood's metal. It is retained so tenaciously by the metal that attempts to recover it in a relatively pure form have not been successful.

When a petroleum lubricant is heated in the presence of air, a marked loss of lubricating power occurs at about 75 deg. C. This change appears to be the result of oxidation. It may be inhibited by adding small amounts of certain substances to the oil. Cyclohexanol and B-naphthol are among the addition agents that show this effect. These particular addition agents also improve the lubricating power of the oil at ordinary temperatures.

(Note.—Identification of this mysterious substance so that it could be synthetically prepared and used to standardize lubricating oils would obviously be a forward step of major importance. Perhaps the "Exanol" products that have lately appeared on the market will show the way.—Ed.)

Mechanism of Oil Viscosity.—W. K. Lewis and Lombard Squires, in OIL AND GAS JOUR., vol. 33 (1934), No. 26, pp. 92–96.

The authors (who are professors at the Massachusetts Institute of Technology) recognize that most technical men are hazy on the subject of the properties of liquids in relation to their structures, especially as to questions relating to viscosity and they have written this long article in an attempt to develop clarity in the qualitative understanding of the situation.

They particularly explain the modern physical concept of the structure of the molecule. This leads to a qualitative explanation of the influence of molecular weight and molecular structure on volatility and boiling point, on liquid density and viscosity. It gives a clear picture of the reasons for the differences in viscosity behavior between liquids and gases, particularly the influences and temperature and pressure. It leads to the unexpected conclusion that for pure liquids the temperature co-efficient of viscosity is determined predominantly by the viscosity itself, always resulting in extremely high temperature co-efficients for viscous liquids.

Passing from the scientific to the more practical aspects of molecular physics they show that modern knowledge of the properties of what may be described as nonhomogeneous liquids, consisting of mixtures of large, chain-like molecules with ordinary liquids, makes it possible to prepare liquids of abnormally low viscosity-temperature co-efficients relative to their viscosities. Mixtures of this type hold promise of developing extreme importance in the field of lubrication, particularly of hydrocarbon lubricants.

Petroleum Chemistry

Significance of Light Translucency of Oil Films.—S. Fischer and Edward Marinoff, in PETROLEUM ENGINEER, vol. 6 (1934), No. 11, pp. 61–65.

In this paper the authors sum up an extensive series of investigations on the translucency of thin adsorbed films of lubricating and other oils. In this research they arrive at two interesting and evidently important criteria of oils, with special reference to Pennsylvania type paraffin base oils.

One of these points of reference is given by the intersection of the curve of percentage light translucency with A.P.I. gravity relationships. This point is identified as the coincidence of A.P.I. gravity of 28.5 deg. and a percentage light translucency of 81 percent.

The other reference point is the intersection of the percentage light translucency curve with the viscosity (S.U.) curve; this point represents a viscosity of approximately 63.8 sec. at 210 deg. F. (S.U.) and a percentage light translucency of about 76 percent.

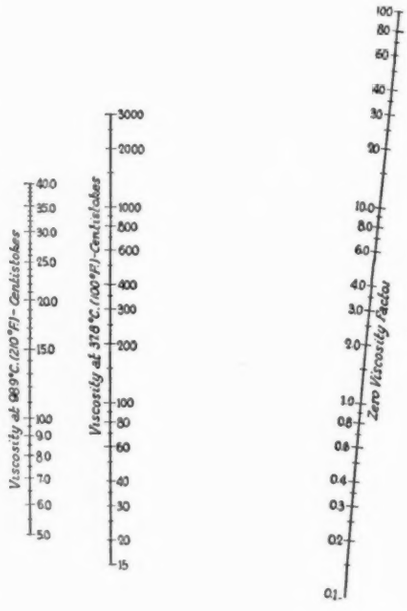
Percentage light translucency can thus be related to two of the most important physical characters of oils. From these relationships the authors are enabled to draw a wide range of practical conclusions. Loss of translucency is an indication of the relative degree of decomposition of an oil in processing; this loss is a measure of the relative durability of an oil and it appears that an oil which will maintain the same percentage of translucency over the greatest range of temperature will be the most satisfactory oil for a given use, but not necessarily for lubrication except in so far as the point of breakdown can be determined by this means; the higher this breakdown temperature the more stable the translucency. Since many oils have a tendency to carbon formation under heat, a measurement of percentage light translucency at different temperatures is a measure of this tendency.

Light translucency and neutralization number of an oil are related in this way: if on heating, the translucency remains constant and the neutralization number is increased, this is due to decomposition of non-translucent substances; if both translucency and neutralization number increase, there is decomposition of both translucent and non-translucent components.

When one becomes familiarized with the translucency and temperature curves of oils it is possible to state the treatment to which an oil of a certain type has been subjected; this may be useful in checking up on the new solvent processes of refining that are coming into vogue. Alkaline clay filtration of naphthene base oils can be readily detected and interesting conclusions drawn.

Evaluating the Viscosity-Temperature Characteristics of Oils.—W. B. McClure and M. R. Fenske, in INDUSTRIAL AND ENGINEERING CHEMISTRY, analyt. ed., vol. 6 (1934), No. 6, pp. 389–392.

With the development of new refining processes by means of which the viscosity-temperature characteristics of oils may be varied appreciably, the problem of evaluating the viscosity characteristics of different lubricants over a wide range in temperature becomes increasingly important. This is especially true of automotive lubricants, because the mechanical parts must be lubricated satisfactorily both at relatively low temperatures and at the relatively high temperatures encountered in severe operating conditions.



Evaluation of this characteristic of lubricating oils on an absolute basis is not yet possible, and must be established on a relative and comparative basis; and in so far as lubrication is dependent on viscosity it seems logical to evaluate oils at two temperature extremes, expressing the results in such fundamental units as the stoke or the poise instead of arbitrary Saybolt units.

The proposed method for comparing the viscosity-temperature characteristics of lubricating oils is largely mathematical in nature and depends on relatively simple procedures and concepts. The steps are outlined as follows:

1. A single type of oil is used for reference purposes.
2. Comparisons are made with oils having equal viscosities at 210 deg. F. (98.9 deg. C.).
3. The 100 deg. F. (37.8 deg. C.) viscosity of the reference oil is expressed in terms of its 210 deg. F. (98.9 deg. C.) viscosity by a simple equation.
4. The viscosity of the reference oil can be calculated at any other temperature by known relations.
5. All oils, if matched as to viscosity at 210 deg. F. (98.9 deg. C.), have a definite viscosity ratio at 0 deg. F.(−17.8 deg. C.) with respect to the reference oil.
6. The 100 deg. F. (37.8 deg. C.) viscosity of any oil having known viscosities at 0 deg. F. (−17.8 deg. C.) and 210 deg. F. (98.9 deg. C.) can be calculated.
7. The mathematical results can be expressed accurately by means of a simple nomograph.

The nomograph devised by the authors is shown in the accompanying illustration.

Petroleum Economics

Control of Gasoline Production.—W. R. Boyd, in OIL AND GAS JOUR., vol. 33 (1934), No. 26, pp. 82–84.

The author, who is chairman of the Refinery Board of Review, offers some information and comment on the present so-called refinery control program to which the industry committed itself by code provision on April 24, 1934. The information given relates to the functions and performances of the national oil administrator, the planning and coordinating committee, the allocators and the board of review. The comment is to the effect that while the primary purpose of the code, namely, to strike a balance between production and distribution has not been perfectly fulfilled at all points, and that in some cases individuals may have been pinched, the existing program is the best that the administrator and the industry have been able to develop. The refiners therefore would do well to observe it until they themselves can make changes

for the better. In any case the industry, in the hope of relief from troublesome competition, should beware of voluntarily and permanently surrendering to the Federal government control of its own business.

CONTROL OF EXPENDITURES IN THE OIL INDUSTRY.—J. Robertson, in JOUR. INST. PETROLEUM TECHNOLOGY, vol. 20 (1934), No. 132, pp. 973–987.

Practical bookkeeping for adequate control of expenditures in the petroleum industry is more difficult to systematize than in any other branch of heavy industry, due to the widely varying and constantly changing natures of the operations. The design of the routine of control falls within the province of the accountant, but the accountant is helpless unless the executives, who control expenditures, cooperate in organizing the general plan of accounting. There are, as the author sets them forth, 44 main points on which the accountant should expect information and guidance if his bookkeeping is to be accurate and informative, and a study of these 44 points can be recommended to oil executives who appreciate correct accounting.

STATE CONTROLLED OILFIELDS IN ROUMANIA AND ITS RESULTS.—Florion G. Dumitresco in MONITEUR DU PETROLE ROUMAIN (1934), No. 20, pp. 1285–1289.

During the first six months of 1934, about 43 percent of the total oil production of Roumania was from land under control of the government, but operated under concession by private companies. Detailed examination of records shows that the total yield from government concessions per running meter of hole is double the yield from privately controlled oil land. The assigned reason is that on the state-controlled fields operations are rationalized; each operator is in sole control of a large area, and wells are so spaced as to secure a maximum of extraction from a small number of wells, with consequent large reduction of expense.

Uses of Petroleum Products

AUTOMOTIVE HIGH-SPEED DIESELS IN HEAVY DUTY TRANSPORT.—Joseph Geschelin, in OIL AND GAS JOUR., vol. 33 (1934), No. 26, pp. 117–121.

The question is raised as to the market for the high-speed automotive Diesel engine and its significance to the petroleum industry at large. The conclusion is reached that an attractive market for such engines now exists and will grow in proportion as improvements are made in mechanical design of the engine and reduction of its maintenance cost.

Ultimate expansion in the Diesel field will depend largely on the fuel situation and possibly on future tax developments. The influence of possible competitive factors is outlined, and a number of such elements are present.

First is the continual improvement in the gasoline engine; but while this is a factor, it is hardly likely that the gasoline engine can possibly approach the inherent efficiency of the Diesel engine. Another element is the development of special devices for burning cheap, heavy fuels in gasoline engines. Then there is the competition from a new source—the availability of new fuels, such as butane and propane, which may be burned in the gasoline engine.

We must reckon also with special engine equipment, such as the Waukesha-Hesselman engine—of which over a thousand have been sold for industrial purposes in this country, and which is designed to burn the cheapest grades of fuel oil. Again, during the course of the last year or so, several new systems have been developed for converting gasoline engines into solid-injection engines of moderate compression ratio operating with spark ignition. The special systems supplied by the Atlas Imperial Diesel Engine Company and Guiberson are examples of this type.

LUBRICATION OF SOLID INJECTION DIESEL ENGINES.—W. G. Gordon, in OIL AND GAS JOUR., vol. 33 (1934), No. 26, pp. 76–80.

Efficient lubrication of Diesel engines presupposes a knowledge of the conditions under which the lubricated parts of such engines operate. This knowledge the author summarizes at considerable length, and in the light of this information a list is made of the qualities that should be possessed by Diesel lubricants, in addition to characteristics specified for power cylinder oils, as follows:

a. High chemical stability: A valuable characteristic, by which certain oils resist the destructive influence of continued circulation with solid and liquid impurities, and of agitation in the presence of air. This characteristic largely determines the durability of an oil, and can be attained only in those high quality oils especially refined for this purpose.

b. Ability to separate readily from solid impurities and water: It is this property which guards against the formation of sludge and emulsions, and which protects bearings from the inevitable destruction that occurs when such impurities, together with broken down products of unsuitable oils, clog the oil pipes and eventually shut off the oil supply.

c. Correct body and fluidity by which is assured the maintenance of effective lubricating oil films under the most severe operating conditions.

These characteristics are attained to a high degree only through the skillful selection of petroleum crudes, and through scientific planning and execution of refining processes—with the sole aim of developing these desirable properties to the highest possible degree. Considerable progress in this direction has already been made.

Petroleum Substitutes

THE ERREN-HYDROGEN MOTOR.—Wendt von Rusenberg, in OEL U. KOHLE, vol. 2 (1934), No. 2, pp. 468–470.

Where hydrogen is available and cheap it can be used with success in a Diesel engine as a substitute for oil fuel, if the compression ratio is suitably changed. Even a small supply of hydrogen can be turned to good account by mixing it with gasoline supplied to internal combustion engines; by this means more rapid combustion of the petroleum fue is assured, and the efficiency co-efficient is raised.

WOOD-FUEL DRIVEN AUTOMOBILES. O. W. Willcox in WORLD PETROLEUM (1934), No. 12, pp. 460–461.

Attention is called to the development of the "gasogene" as a means of supplying power to automotive vehicles. The gasogene is a small gas generator

in which finely chopped wood is subjected to destructive distillation with production of combustible gas that is conducted to the internal combustion engine. It appears that considerable interest has been aroused in this source of power, and a growing number of trucks, omnibuses, and even passenger automobiles powered in this manner is already in use in various European countries.

Prospects for Gasoline from Coal Tar.—E. Moehrle, in OEL UND KOHLE, vol. 2 (1934), No. 11, pp. 506–510.

The author undertakes to put the question of gasoline manufacture from coal tar in the proper perspective. The most suitable raw material for the purpose is the crude tar obtained from the low temperature carbonization of coal—the lower the temperature of carbonization, the better. Five million tons of gas coal will yield 400,000 tons of tar, which by simple distillation yields 25,000 tons of directly usable gasoline, 110,000 tons of phenol—containing gas oil suitable as Diesel fuel and 260,000 tons of higher boiling oils and pitch from which, by hydrogenation, a further 210,000 tons of gasoline may be obtained. The combined result is about 3,450,000 tons of the two classes of motor fuel. The present consumption of gas coal in Germany is 5,000,000 tons, so that the by-product tar can cover about 25 percent of Germany's imports of motor fuel—if and when all the available tar is actually hydrogenated. If the attempt is made to increase gasoline production from this source, new uses for the by-product coke must be found.

Wood-gas Generators in Automotive Traction.—Bruno Muller in PETROLEUM ZEITSCHRIFT, vol. 30 (1934), No. 42, pp. 5–6.

Particulars are given of the construction and operations of wood-gas producers and their performance as sources of power for trucks, etc. It is said that more than 1,000 trucks using this power are now in operation in Germany. The Deutz firm are the principal German builders of these gas-producers for automotive vehicles.

Determination of Alcohol Content and Water Tolerance of Alcohol-petrol Blends. W. R. Ormandy, I. W. M. Pond and W. R. Davies in JOUR. INST. PETROLEUM TECHNOLOGISTS, vol. 20 (1934), No. 132, pp. 913–935.

The authors offer a practical method for determining the alcohol content and water tolerance of gasoline-alcohol mixtures. The method consists in adding a standard excess of water to a given volume of the blend and measuring the volume of the alcohol-rich layer. The influence of temperature and the possible presence of benzole are taken into consideration and tables for evaluating the results are given. Since low-cost 99.5 percent alcohol has become available the blends on the British market now have a large margin of safety in the matter of water tolerance.

Lubricating Oils from Ethylene.—R. G. Atkinson and H. H. Storch, in INDUSTRIAL AND ENGINEERING CHEMISTRY, vol. 26 (1934), No. 10, pp. 1120–1122.

It has been estimated that the amount of olefins in commercial gases and in other sources from which it could be obtained (natural gas, cracking-still gas, waste gas from natural gasoline plants, etc.) amounts to 14,000,000,000 cubic meters per year. This makes finding profitable uses for olefinic gases in large quantities a matter of much interest to industrial chemists.

The experiments described by the authors indicate that it should be possible to produce a good "light" lubricant from the lower members of the olefin series by a two-stage process, the first step being a thermal polymerization to a liquid boiling in the gasoline range. The material produced in this manner can then be polymerized by aluminum chloride to a viscous liquid suitable for a lubricant.

While there are not enough data available to enable one to predict anything about the commercial applicability of the process, it is thought that further investigations should prove of value.

Books on Petroleum

Compilation of Official Geological Studies in Colombia, 1917–1933. Vol. 1.

This is the first of a series of five volumes which will give a résumé of all geological studies made by members of the Colombian Geological Survey. The present volume comprises the work of Dr. Robert Scheibe, Colombia's first official geologist.

The Chemistry of Petroleum Derivatives, by Carlton Ellis (Chemical Catalog Co., New York, 1934), 1153 pages, with index of 134 pages; $18.

This monumental, closely printed book is intended as a fairly exhaustive survey of the literature of the chemistry hydrocarbons with prominent reference to petroleum products; it is, without doubt, the most ambitious work of the sort ever carried to conclusion. The index of authors and subjects alone covers 134 pages, attesting the thoroughness with which the field has been covered. The subject matter is well arranged for easy reference and the petroleum chemist will find it most useful as a standard reference book.

How can we reduce the loss of volatile solvents? (Wie setzen wir die Verluste an fluchtigen Losungsmitteln herab?), by E. Schwarz, published 1934 by Allgemeiner Industrie-Verlag, Berlin. 9 RM.

In numerous operations in chemical technology volatile solvents are used for a great variety of purposes. As these solvents are generally expensive the problem of recovering them after use is of much importance. The present volume covers this problem in detail for a large variety of processes and solvents. With the advent of selective solution in petroleum refining, solvent recovery becomes of more economic interest in this industry, not to mention the recovery of volatile values from refinery and natural gases. The book can be recommended for the information it gives on these subjects.

Oil and Petroleum Year Book. Compiled and published by Walter E. Skinner, 15 Dowgate Hill, Cannon Street, London, E. C. 4, England (1934). 458 pp.; 7s. 6d. net; or post free (domestic) 8s. (foreign) 8s. 6d.

In this book are listed British and other companies covering the fields of producing, refining, transporting and merchandising petroleum products; financing concerns are also included. Lists are given of the officers and directors of the companies, and there is a list of consulting oil engineers, managers and agents associated with these concerns. The histories and financial structures of the companies are summarized. Other features of the book are petroleum production statistics, with particular reference to production by the larger British concerns, a list of petroleum products with their trade names, and a glossary of technical terms.

Prize for Heavy Oil Motor

To stimulate the development in France of aviation motors using heavy oil, the Air Ministry has offered a prize of 10 million francs under the following conditions: It must be of French construction and, before December 31, 1936, must enable an aviator to beat the speed record over a closed course of 10,000 kilometers now held by Doret and Le Brix, this record being an average of 149.853 kilometers per hour. If the motor is of French construction from a foreign design the prize is reduced to 5 million francs. Any advances made by the government toward construction of the motor will be deducted from the prize money.

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A NEW company has been formed in Italy to erect a refinery near Foggia, if a concession is granted by the Fascist Government. This is the Cispadana, or Societe Industrie Chimiche e Minerarie, located in Milan.

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Books

THE SECRET WAR by F. C. Hanighen, The John Day Company, New York; $2.75.

In the introduction to F. C. Hanighen's "The Secret War" it is claimed that Mr. Hanighen has adapted to the world of 1934 the methods originated by the McClure school of muckrakers thirty years ago. There is one important difference, however. Ida M. Tarbell, Lincoln Steffens and other writers who made the name of MCCLURE'S MAGAZINE celebrated by their disclosures of abuses in big business and municipal politics prefaced the publication of their articles by painstaking research and investigation. Even after the lapse of years Miss Tarbell's writings retain authority as a contribution to the history of the times with which she dealt.

Compared to this old-fashioned system the method followed by Mr. Hanighen is distinctly modern. It consists apparently of stringing together the more sensational statements of other writers, newspaper reports, rumors and gossip of the kind that circulate extensively among news writers, without much effort at winnowing the chaff from the wheat. The result is an interesting and dramatic tale but one that as a historical record takes rather too much for granted.

Oil certainly has played its part; and at times a most important part, in national and international politics for more years than most of us can remember but in Mr. Hanighen's story everything that has happened since the turn of the century, except the world war itself, is explained in terms of oil. Rockefeller and Deterding are the dominant powers contending for world supremacy at whose behests governments rise and fall, plots and counterplots are spun, lives and property are sacrificed on a grand scale. It would be more convincing if we had not been asked by the writers of other recent volumes to believe the same things of the munitions makers, the bankers and the big capitalists of steel, transportation and other industries.

Oil men will find this volume diverting if nothing more. They will be surprised to learn, for example, that Shell's operations in the United States are not a mere prosaic commercial undertaking but a deep laid scheme to help exhaust America's petroleum resources so that the sceptre of oil supremacy may pass to the other side of the Atlantic. There is other "inside information" equally astonishing.

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Submergible Pump Adapted to Oklahoma City Wells

FOR SEVERAL years past a submergible centrifugal electrical pump has been used with satisfactory results in shallow fields of Texas and Oklahoma, and such unit, upon introduction into the Oklahoma City field wells with depths of 6,500 ft., has been found to perform efficiently and economically.

In general it may be stated that while in other industrial applications of pumping equipment centrifugal electrical pumps superseded reciprocating pumps, in oil well pumping reciprocating pumps are still used, while the power is still transmitted to the plunger by mechanical means, sucker rods, not only in the well itself but also on the surface from the central power houses. Millions of feet of these connecting sucker rods are in use in the oil industry. The use of this equipment has been necessitated by very difficult conditions in the wells and the apparent impossibility of adapting electric motor to submerged conditions of an oil well. No other field of electrical motor application developed long and radially small but powerful enclosed motors that could be lowered into 6-inch casing, and it was not until the Reda Pump Company of Bartlesville, Oklahoma, began manufacturing such motors and centrifugal pumps, under patents of A. Arutunoff, that such equipment was considered at all feasible. The problem involved an entirely new field of motors, pump and cables to transmit the power 4,000 to 6,000 feet into wells to equipment submerged in oil and salt water, often lifting sand and shale cavings with the fluid.

As finally developed, the Reda submergible centrifugal electrical pumps have been used for several years with considerable success in parts of Texas and Oklahoma. These pumps are designed to handle large volumes of fluid at low pressure, that is with lift in feet not exceeding a certain low figure relative to capacity in gallons per minute. Under current prorated production the Reda pumps have been used principally in wells handling large volumes of salt water, and to date most Reda units are installed in wells averaging five percent oil and 95 percent water. In Sedgwick County, Kansas, No. 1 Goodrich with an estimated ultimate recovery of 160,000 bbl. of oil, produced on Reda pump 383,300 bbl. in 21 months; in Wink pool, West Texas, No. 3 T-88-U with an estimated ultimate recovery of 20,000 bbl. produced on Reda pump 74,705 bbl. in 13 months; and in Ada, Oklahoma, No. 2 Coker, estimated to be capable of beam pumping 195,000 bbl. of oil in seven years, produced on Reda pumps 394,255 bbl. in three years.

To Oklahoma City field conditions have been adapted Reda 130 stage centrifugal pumps driven by 97.5 horsepower, 3-phase, 750 volt motors, producing 1,000 to 1,200 bbl. per day from 6,500 ft. depths. Production costs are estimated at 1 cent per 1,000 feet of lift, or at about 6.5 cents per barrel, including power (2 cents per barrel), interest and amortization of equipment, cost of repairs and upkeep. Phillips Petroleum Company has installed Reda pumps in 7 of its Wilcox sand zone wells, and these units have been in operation for the last six to nine months. Because of considerable sand lifted with the fluid, some pumps have required repairs, while others have operated without repairs for the last eight months. It is a remarkable progress of electrical and pump design when it is realized that this equipment is confined to five- to nine-inch radial casing space into which motors up to 250 h.p. and pumps with capacities up to 8,000 bbl. per day are built, and operated submerged in oil and water under varying subsurface temperatures.

World Oil Production—Official Figures for 1934 Revised

All figures furnished direct to WORLD PETROLEUM by Governments, except where otherwise specified

(Figures in U. S. Barrels—Conversion ratio 7 bbl. = 1 ton)

Country	November 1933	December 1933	January 1934	February 1934	March 1934	April 1934	May 1934	June 1934	July 1934	August 1934	September 1934	October 1934
United States	69,755,000	72,060,000	71,976,000	65,450,000	75,548,000	75,796,000	79,870,000	80,040,000	81,548,000	79,058,000	75,810,000	76,776,000
Russia	13,479,200	12,591,600	13,356,000	12,488,900	14,644,000	14,081,900	14,315,000	13,966,400	14,297,500	14,287,700	13,924,400	14,260,000
Venezuela	10,843,910	11,253,704	11,091,415	9,921,765	11,238,717	11,185,076	11,768,799	12,500,307	12,193,307	12,505,304	12,381,159	12,591,390
Roumania	4,000,000	4,515,000	4,906,000	4,440,000	5,066,000	4,981,000	5,258,000	5,228,000	5,223,000	5,556,000	5,335,000	5,467,000
Persia [2]	4,199,797	4,422,096	4,164,790	3,988,502	4,483,535	4,284,231	4,648,105	4,399,045	4,577,251	4,886,462	4,955,419	4,499,530
Mexico	2,833,630	3,259,258	3,113,707	2,863,088	3,183,923	3,206,490	2,714,828	2,918,793	3,303,055	3,434,516	3,276,612	3,393,770
Netherland India	3,127,047	3,414,754	3,376,674	3,185,091	3,631,726	3,489,024	3,609,816	3,577,056	3,678,745	3,456,215	3,410,785	3,577,399
Colombia [4]	999,253	995,605	1,012,780	903,471	1,017,147	1,193,736	1,730,095	1,683,691	1,646,739	1,691,314	1,627,632	1,646,293
Argentina	1,296,166	1,216,461	1,241,591	1,111,358	1,231,978	1,128,922	1,029,074	1,096,855	1,077,502	1,210,273	1,258,812	1,678,500 [1]
Peru [4]	998,066	1,178,004	1,188,540	1,041,658	1,086,827	1,037,127	1,085,192	1,187,030	1,233,804	1,300,253	1,259,901	1,303,554
Trinidad	788,970	799,484	852,189	766,254	876,544	876,950	926,785	947,122	1,008,669	975,697	919,469	950,100 [1]
British India	667,719	701,478	782,743	699,369	808,647	759,977	796,208	749,294	700,000 [1]	700,000 [1]	700,000 [1]	700,000 [1]
Poland	309,624	311,500	312,333	281,946	310,800	304,500	305,592	304,437	315,861	320,145	311,003	315,000
Sarawak	179,648	176,008	172,172	158,361	176,568	166,999	166,565	158,669	164,206	161,504	155,400	156,800
Japan and Taiwan	111,127	114,082	112,927	99,481	109,303	111,794	118,578	120,390	130,284	135,000 [1]	137,000 [1]	138,500 [1]
Egypt	128,450	127,421	122,934	109,900 [1]	121,121	117,236	130,851	132,097	135,106	131,061	124,502	123,235
Ecuador	133,591	138,198	132,655	120,900	131,566	135,226	142,869	158,826	141,474	140,944	136,033	141,079
Canada	108,304	113,677	124,425	116,546	130,046	118,890	117,693	109,021	120,772	114,778	114,242	122,056
Germany [3]	157,808	155,491	152,292	138,593	159,096	176,071	159,103	179,480	208,145	219,961	198,366	227,605
Iraq [1]	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
France [1]	46,000	46,000	46,000	46,000	46,000	46,000	46,000	46,000	46,000	46,000	46,000	46,000
Others [1]	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000	36,000
Total	114,249,304	117,725,821	118,374,167	108,067,183	124,137,544	123,333,149	129,075,153	129,638,513	131,885,420	130,467,127	126,217,735	128,249,811

[1] Estimate. [2] Anglo-Persian Oil Co. figures revised; fuel oil returned to the ground has been deducted. [3] Thuringia estimated 7,000 bbl.; official figure for Prussia. Russian Sakhalin included with Russia. Japanese Sakhalin included with Japan. [4] International Petroleum Company's figures.

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Official Crude Oil Production Figures for 1932, 1933 and First 10 months of 1934

(Barrels of 42 U. S. Gals.)

	Total 1932	Daily Average 1932	Total 1933	Daily Average 1933	Total 1934	Daily Average 1934
United States	785,159,000	2,145,243	898,874,000	2,462,670	761,872,000	2,539,573
Russia	149,719,000	409,070	149,901,900	407,950	139,621,800	465,406
Venezuela	119,596,512	326,766	120,882,802	331,186	117,377,239	291,257
Roumania	50,491,205	137,954	50,971,200	139,647	51,460,000	171,533
Persia	45,122,455	123,285	49,581,280	135,840	44,886,870	149,623
Mexico	32,802,285	89,624	33,904,882	92,890	31,408,782	104,696
Netherland India	39,584,027	108,153	38,512,663	105,516	34,992,531	116,642
Colombia	16,384,956	44,768	13,157,127	36,047	14,152,898	47,176
Argentina	13,166,900	35,975	13,759,565	38,232	12,064,865	40,216
Peru	9,899,266	26,026	13,923,281	38,146	11,723,886	39,080
Trinidad	10,023,780	27,387	9,560,039	26,192	9,099,779	30,332
British India	8,600,312	23,500	8,721,665	23,893	7,396,238	24,654
Poland	3,905,230	10,670	3,858,085	10,570	3,081,617	10,272
Sarawak	2,274,043	6,213	2,289,472	6,273	1,637,244	5,457
Japan and Taiwan	1,575,333	4,375	1,377,761	3,827	1,213,257	1,200
Egypt	1,742,370	4,760	1,591,495	4,360	1,248,043	4,160
Ecuador	1,573,857	4,300	1,622,624	4,446	1,381,572	4,605
Canada	1,054,373	2,880	1,147,825	3,144	1,188,469	3,961
Germany	1,824,019	4,983	1,712,823	4,692	1,818,712	6,062
Iraq	1,200,000	3,300	1,200,000	3,288	1,000,000	3,333
France	552,000	1,508	552,000	1,515	460,000	1,533
Others	432,000	1,180	432,000	1,184	360,000	1,200
Total	1,296,712,823	3,544,940	1,417,312,555	3,884,022	1,249,445,802	4,161,979

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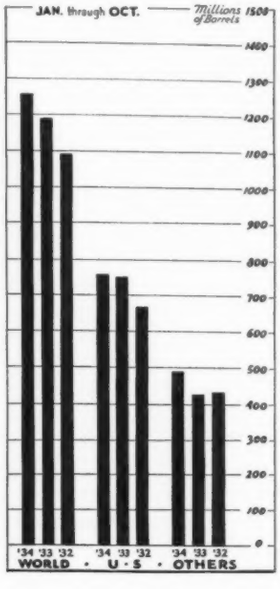
Comparison of crude oil production in the United States, all other countries and total for the world during January through October, 1932, 1933 and 1934.



Foreign Oil Legion

L. B. LEVI, Director of Exports and Refining, Socony-Vacuum Oil Co., and party, is on a business tour in Great Britain and the Continent, proceeding as far as Stamboul, via Vienna.

JOHN H. BAIRD, New York and foreign sales representative for several large American manufacturers of oil well equipment has enlarged his representation to include the Security Engineering Company of California. Mr. Baird is located in the Graybar Building in New York City.

RODOLFO P. PERACCA, agent in Argentina, Uruguay and Brazil for Lobitos Oilfields Ltd. and Anglo-Ecuadorian Oilfields Ltd., has returned to Buenos Aires after a trip to the United States and Europe.

Through the intervention of Mr. Peracca a contract has been concluded by which the crude oil requirements of the new refinery of Administracion Nacional de Combustible Alcohol Y Portland (A.N.C.A.P.) at Montevideo will be supplied by Lobitos and Anglo-Ecuadorian. The construction of the refinery is now under way.

N. O. WATSON is now heading Shell production interests in the Maracaibo Basin, Venezuela, in the position of general manager with headquarters in the suburbs of Maracaibo.

J. A. CLARK, general superintendent, Lago Petroleum Company, Maracaibo, has returned to Venezuela following a vacation in the United States.

M. C. SEAMARK, designer of the well-known blow-out preventer, is in charge of the Anglo-Persian Oil Co.'s operations in the Ciudad Bolivar district of Eastern Venezuela, in connection with the Orinoco Oilfields Ltd.'s concessions.

GORDON MICHLER, Standard Oil Co. of New Jersey recently returned to New York from South America.

AT THE Ordinary General Meeting of the Institution of Petroleum Technologists held at the Royal Society of Arts, the President announced that Sir John Cadman, G.C.M.G., Hon.LL.D., D.Sc., had been unanimously elected President for the Session 1935–36, to take office immediately after the Annual General Meeting.

DR. FOOTNER, who has been making an extensive investigation throughout the world on the effect of climatic conditions upon paint for the Asiatic Petroleum Company Ltd., is now in London.

THE IRAQ PETROLEUM COMPANY is chartering an Imperial Airways plane, the SCYLLA, to take some of the directors and other distinguished guests to the opening of the line. The plane will leave England on the 7th of January.

F. GODBER, director, Royal Dutch-Shell group, has left London for an extended trip to the Far East in connection with the business of the Asiatic Petroleum Co. Ltd.

Charles W. Hadley

IT HAS been announced that Charles W. Hadley, chairman of the manufacturing committee of the Socony-Vacuum Oil Company will retire at the end of 1934, having been with the company for 44 years. Mr. Hadley began his career with the Standard of New York in 1890 and joined Vacuum in 1910.

N. S. ERSLEIGH, chairman, Anglo-Transvaal Consolidated Investment Co. has recently come to London for the purpose of launching a public issue of 1,000,000 ten shilling shares for developing shale deposits in South Africa by the African Tarbanite Mining and Refining Co. in which the British Burmah Petroleum Co. is interested.

F. Godber

U. S. S. R.

Official Figures for Soviet Oil Operations

1934	Crude Production (bbl.)	Daily Average (bbl.)	Run to Stills (bbl.)	Drilling (feet)
January	13,356,000	430,840	11,680,000	317,011
February	12,488,000	446,000	10,621,800	321,509
March	14,644,000	472,000	12,257,000	360,096
April	14,081,000	469,397	12,637,100	353,311
May	14,315,000	461,774	13,101,900	384,793
June	13,966,000	465,546	12,363,400	385,387
July	14,397,000	461,210	12,744,900	402,267
August	12,287,700	460,893	12,693,200	353,099
September	13,924,400	464,147	11,969,300	318,123
October	14,699,300	473,970	11,799,900	319,126
November	14,388,500	478,335	11,212,600	291,466
Total 11 months 1934	152,546,900	456,620	133,481,100	3,806,188
Total 11 months 1933	136,311,000	408,116	120,007,300	2,277,163
Total 1933	149,901,900	407,096	131,591,300	2,789,253
Quota 1933	170,800,000	467,670	135,000,000	3,315,000
Quota 1934	214,900,000	588,876	161,000,000	4,950,000
Possible Production 1934	170,000,000	466,000	146,000,000	4,200,000

Crude conversion: one ton = seven bbl.

APPROXIMATELY 81 percent of the plan for the year in crude oil production for all Russia has been completed during the 11 months past leaving for completion during December about 19 percent of the plan. The rate of plan fulfillment for all combustibles and fuels including coal and electricity during the 11 months past has amounted to approximately 90 percent.

Crude production and runs to stills are running ahead of last year but arrears against plan for the year are apparently going to exist at the year-end.

Drilling is the brightest spot of the oil industry showing an excess in operations of about 75 percent over the corresponding figure for the same time last year and the distance drilled is almost in accordance with the plan.

Production of gasoline during the period shows about 85 percent of plan fulfillment, but the increase over last year is almost negligible (about one percent) and this is due solely to retarded operations at Grozni. About 50 percent of crude run to stills at Grozni is being shipped from Baku in order to keep the Grozni refineries under stream near capacity.

Deep Drilling

IT has been pointed out that there are at present about 1,150 drilling tables under operation in all Soviet oil fields of which 270 units or about 26 percent are fitted with three and four speed hoists for heavy duty and drilling below 5,000 feet. Up to the present the average drilling depth does not exceed 3,000–3,300 feet at Baku and 3,300–3,600 feet at Grozni and elsewhere.

The number of pumps coupled with drilling tables does not exceed 1,200 units of which about 24 percent are heavy duty pumps for deep drilling. Deep drilling in general is performed with two pumps to each drilling table and this shows first of all that the number of wells under deep drilling in Soviet fields is not high and secondly that there is not sufficient equipment for deep drilling.

Baku

SEVERAL new wells have come in at the various groups of Baku oil fields some of which are important commercial producers. No appreciable improvement however can be expected in general at this time when inclement weather makes drilling, production and all other operations difficult.

Soviet Oil Exports

	8 Months 1934 (tons)	8 Months 1933 (tons)
Crude Oil	151,443	139,959
Gasoline	829,068	981,665
Kerosene	268,298	445,434
Gasoil	393,761	414,152
Fuel- and Diesel oil	926,618	1,178,010
Lubeoil incl. Bright Stocks	175,294	172,699
Asphalt	24,235	26,293
Wax	7,779	3,414
All other	703	245
Total	2,777,199	3,361,871

J. WEGRIN

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Gulf Export Prices for Major Oil Products

	Product	Cents per Gallon Nov. 22	Nov. 30	Dec. 6	Dec. 14
Gasoline:	U. S. Motor	4	4¼	4¼	4⅜
	64/66–375 E. P.	4⅜	4⅜	4⅝	4¾
	59 Oct. & below	4¾	4¾	4¾	4½
	65 Oct. & above	5¼	5¼	5⅛	5
Aviation Gasoline:	73 Oct. & above	10½	10½	10½	10½
Kerosene:	44 w.w.	4¼	4¼	4¼	4½
	41–43 w.w.	4⅛	4⅛	4⅛	4⅜
	41–43 p.w.	4	4	4	4¼
Gasoil:	26–30 translusc.	3¼	3¼	3¼	3¼
	30 plus translusc.	3⅜	3⅜	3⅜	3⅜
Fuel Oil:	Bunker purposes (per bbl.)	$1.00	$1.00	$1.00	$1.00
Grade C:	Cargo lots (per bbl.)	$ .78	$ .80	$ .80	$ .80
	Diesel oil (per bbl.)	$1.70	$1.70	$1.70	$1.70
Lubricating Oil:	Bright Stock No. 8	22	23	23	23
(New York Export	Bright Stock No. 6½	21	22	22	22
Market)	Warren E.	19	19	19	19
	600 Unfilt.	15¼	14½	14½	14½
	650 Unfilt.	18	17½	17½	17½
	600 Flash s.e.	18½	18	18	18
	630 Flash s.r.	22½	22	22	22
	Neutral 200 No. 3	35	35	35	35
	Neutral 150 No. 3½	28	28	28	28
So. Texas:	300 No. 3 pale	7	7	7	7
	500 3½ pale	7⅞	7⅞	7⅞	7⅞
	750 4 pale	8¾	8¾	9	9
	1200 4 pale	9¼	9¼	9½	9½
	500 No. 5–6 red	7⅞	7⅞	7⅞	7⅞
	750 5–6 red	9	9	9	9
	1200 5–6 red	9¾	9¾	9½	9½
Crude Oil:	East Texas crude delivered at Gulf port for Export	$1.18	$1.20	$1.20	$1.1

UNITED STATES

	Daily Crude Oil Production bbl.	Daily Runs to Stills bbl.	Total Motor Fuel Stocks bbl.	Imports for week bbl.	California Shipments East for week bbl.
Week ending Nov. 10....	2,410,000	2,415,000	49,651,000	697,000	458,000
	420,500*				
Week ending Nov. 17....	2,431,000	2,555,000	48,810,000	711,000	382,000
	429,000*				
Week ending Nov. 24....	2,369,000	2,565,000	49,139,000	709,000	662,000
	421,500*				
Week ending Dec. 1.....	2,420,500	2,400,000	49,809,000	886,000	215,000
	463,000*				
Week ending Dec. 8.....	2,386,850	2,475,000	50,209,000	877,000	776,000
	463,300*				

Underlined figures indicate improvement in statistical position—decrease in production, runs to stills, gasoline stocks and imports.
*** Estimated total production of the Rusk-Gregg field, East Texas, official and unreported.**

Control Developments

THERE were no new developments during the past month in the federal control situation. The three-man federal tender board continued to function satisfactorily in East Texas, eliminating probably all of the "hot" oil production from interstate commerce. Texas Railroad Commission continued its full cooperation with the federal tender board and the federal allowance for the state of Texas of 941,300 bbl. for December, was actually cut by the Commission to 936,277 bbl. As was indicated in the preceding issue of WORLD PETROLEUM the fact that the tender board does not in any way interfere with the internal affairs of Texas has been responsible for such full cooperation. The federal tender forms were simplified early in December, and natural gasoline moving out of East Texas field in interstate commerce was added to the list of petroleum products requiring tenders.

On December 10 the United States Supreme Court heard oral arguments in the test case brought up by two East Texas concerns, the Amazon Petroleum and Panama Refining Companies. The primary issue involved is the constitutionality of federal control of crude oil production. The Department of Justice, previous to the opening of the hearings, filed with the Supreme Court a voluminous brief asserting that the production control provisions of the petroleum code are within the powers of Congress, do not violate the constitution and were specifically authorized by the NIRA.

The Supreme Court is not expected to render its decision until early February, 1935, but it is anticipated it will sustain the right of the federal government to restrict production as a measure of conservation of a natural resource.

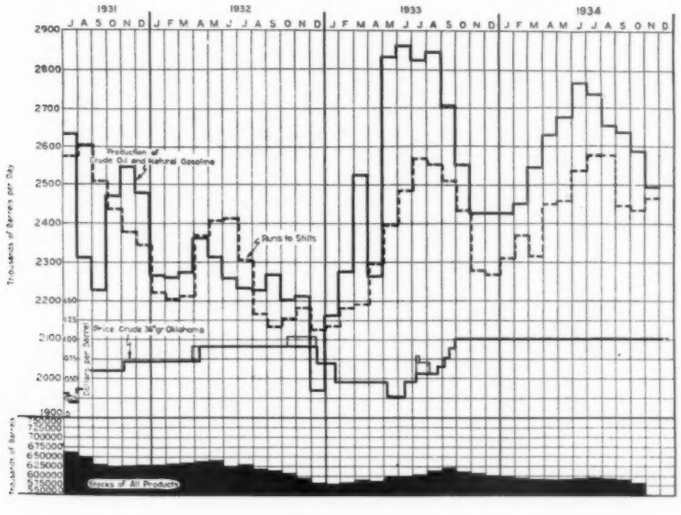
Secretary of the Interior and Petroleum Administrator, H. L. Ickes, during the past month watched carefully the developments within the industry, feeling his way for federal regulations after June, 1935, when the NIRA expires. In the federal organization itself, Charles Fahy succeeded N. Margold as the Chairman of the Petroleum Administrative Board, while Judge Amos L. Beaty resigned, effective December 17, as the chairman of the Planning and Coordination Committee, no successor having been named as yet. Four important meetings took place in the last thirty days. The American Petroleum Institute meeting in Dallas, the conference of governors of the oil producing states in Ponca City, Okla., the Independent Petroleum Association of America meeting in Fort Worth, Texas, and the extended hearings before the Congressional Committee investigating the oil industry in Oklahoma City, Dallas and Los Angeles.

The American Petroleum Institute meeting in Dallas was reported in detail in the December issue of WORLD PETROLEUM.

The abortive one-day conference of governors of oil producing states in Ponca City, Oklahoma, on December 3, ended in a complete fiasco. Governor A. M. Landon of Kansas favored temporary federal control, until states are willing to join in an interstate compact; while Governor-elect of Texas, J. V. Allred, expressed himself definitely against federal control and interstate compacts, though it is definitely considered that the Governor-elect is in favor of federal crude oil production allocations and interstate control of shipments, but is against anything that may and eventually would develop into petty, interstate disputes.

The Congressional Committee investigating the oil industry, headed by William P. Cole,

U. S. production, runs to stills and price of crude oil in relation to stocks of all petroleum products.


1931
1932
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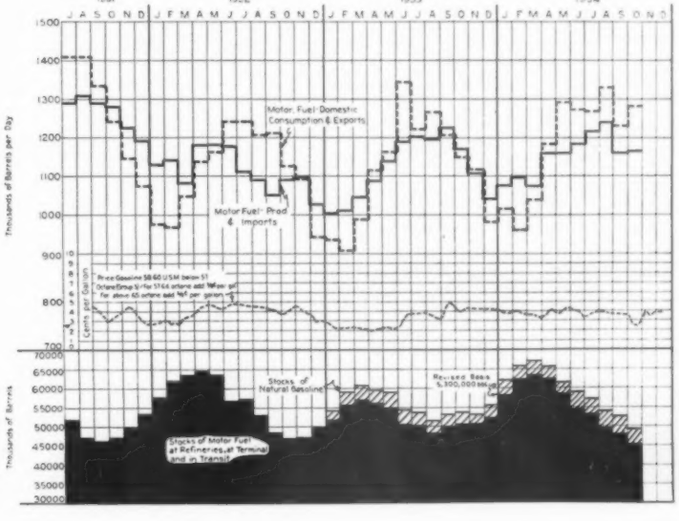
Thousands of Barrels per Day
Production of Crude Oil and Natural Gasoline
Runs to Stills
Price Crude 36°gr Oklahoma
Dollars per Barrel
Thousands of Barrels
Stocks of All Products

U. S. consumption and exports, production, imports and prices of motor fuel in relation to motor fuel stocks.


1931
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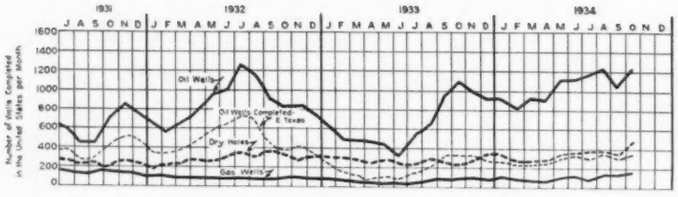
J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
Thousands of Barrels per Day
Motor Fuel-Domestic Consumption & Exports
Motor Fuel-Prod & Imports
Cents per Gallon
Thousands of Barrels
Stocks of Natural Gasoline
Stocks of Motor Fuel at Refineries, at Terminals and in Transit


1931
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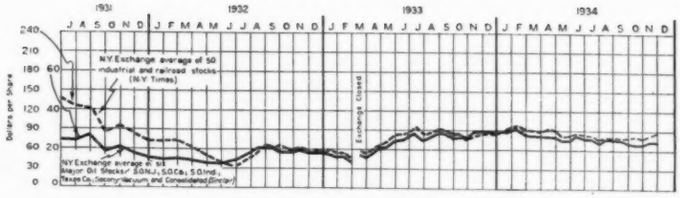
J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
Number of Wells Completed in the United States per Month
Oil Wells
Oil Wells Completed in E. Texas
Dry Holes
Gas Wells

U. S. drilling; comparison of oil wells, dry holes, and gas wells.


1931
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1933
1934
J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
Dollars per Share
N.Y. Exchange average of 50 industrial and railroad stocks (N.Y. Times)
Exchange Closed

Six major oil stocks in relation to 50 industrial stocks on the New York Stock Exchange.

Jr., Maryland, completed its six-month investigation early in December and its report to the new Congress will be submitted during January, 1935. The outstanding statements at late hearings in Dallas and in Los Angeles included that of W. Pratt, vice-president of the Humble Oil and Refining Company (S.O.N.J.), who indicated that the crude oil reserves of the United States are limited to 10 to 12 years demand, and that new discoveries are inadequate to replenish the withdrawals; Harry F. Sinclair of the Consolidated Oil Corporation stated that he believes that the oil reserves are ample for a century and expressed his preference for interstate compacts, as opposed to centralized federal control; J. R. Pemberton, State Umpire of California, told the Committee that California faces a crude oil shortage "within a few years".

The Independent Petroleum Association of America reaffirmed its October recommendation, favoring: "A limited form of federal regulation, such as limiting imports; limiting withdrawal of crude from storage; keeping production to consumer demand; and permitting states to band together as a compact, with the federal government as an umpire, or to submit figures on what national and state production allowables should be."

On the whole the question of control in the petroleum industry shapes itself as follows, and the following division of authority may be considered to be advantageous to the industry:

1. Thomas-Disney Federal Control Bill is generally opposed, and is considered unnecessary and harmful by the majority of leaders in the industry.

2. Control of the industry through interstate compacts is favored by many within the industry, but probably principally as a relief from strict federal control. Interstate compact, however, would be merely an inefficient palliative, it being too difficult to reconcile the interests of the various states, while a cumbersome machinery would be created, not taking into consideration the difficult question of which state would be the leader in such a compact.

3. Federal Board for allocation of crude oil production among the various states is generally realized as necessary—and could operate under authority for conservation of a natural resource. The regulation would be synonymous with stabilization of prices.

4. The enforcement of federal state allocation is to be dependent upon regulation of interstate shipments.

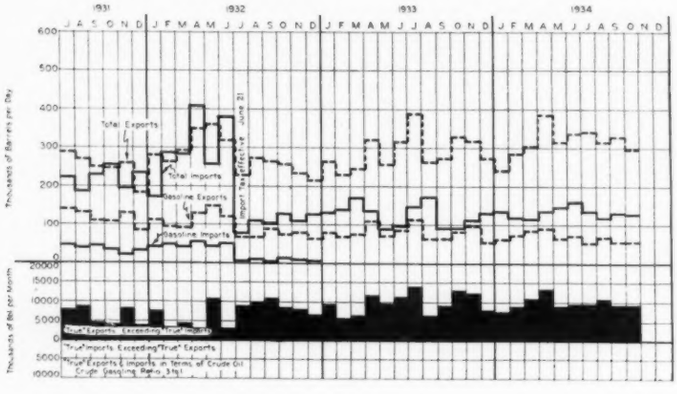
5. Federal Board of Allocations to have authority to control imports; however, with due respect to the fact that imports in a measure are a reserve source of crude oil for the United States and that every barrel imported conserves one barrel at home and that petroleum products are imported by American companies.

6. Desirability of uniform state proration laws.

7. Desirability of repeal in courts of the law of "capture" as applied to oil production, and a qualified substitution for it of a "reservoir" law, which will be based upon acre-feet of sand and bottom-hole pressures.

8. Desirability of special state unitization laws to enforce unitization of lease and royalty holdings on tracts of under 10 acres, this to include specifically town lots.

9. The marketing problem embracing the difficult question of dealers' margins and differential prices between branded and unbranded motor fuel is to be regulated by regional special temporary arbitration boards, composed of both groups, with a federal commission cooperating eventually to stabilize the retailing markets. This question is immensely troublesome because of the great excess of service stations, and could be effectively solved once and for all only by razing one half of all outlets.


1931
1932
1933
1934
J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
Thousands of Barrels per Day
Total Exports
Total Imports
Gasoline Exports
Gasoline Imports
Import Tax Effective June 21
Thousands of Bbl. per Month
"True" Exports Exceeding "True" Imports
"True" Imports Exceeding "True" Exports
"True" Exports & Imports in terms of Crude Oil
Crude Equivalent Ratio, 3 to 1

Total U. S. imports and exports and gasoline imports and exports in relation to true exports exceeding true imports.

Texas Situation

WITH interstate shipments of "hot" oil out of East Texas field reduced to practically nothing, the operators running illegal oil began shipments in intrastate commerce to various points in Texas, and these shipments jumped to some 50,000 bbl. per day in the week ending December 8 just previous to the enforcement of the new State of Texas law requiring tenders for intrastate shipments. The tenders for shipping crude oil from East Texas were required by the Texas Railroad Commission since February of 1932, but the first law was held invalid by courts. It is anticipated that the new law, effective December 25, will be sustained in courts, inasmuch as the Third Court of Civil Appeals in Austin held recently that the House Bill 99 empowers the Texas Railroad Commission to regulate both the refining and transportation of petroleum products.

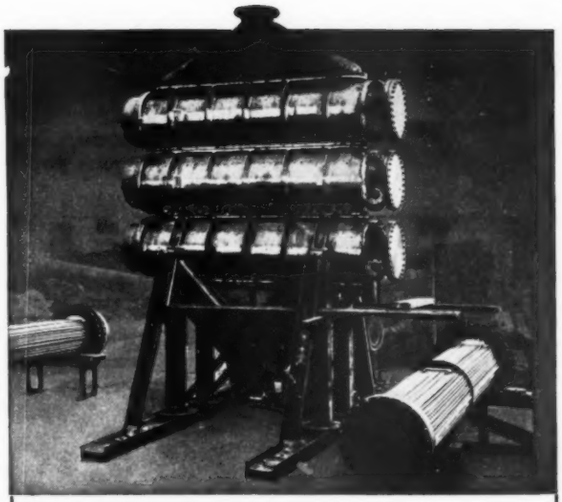
The Texas Railroad Commission is setting up at this time an organization for issuing tenders for intrastate commerce and for supervision of such shipments, though the Commission fell into the error, made already once by the federal government, of planning the enforcement of federal regulation in all Texas fields, a huge, expensive, and unwarranted undertaking. The inter- and intrastate shipment control by separate cooperating federal and state commissions should be definitely limited to fields with excessive production, and should not affect oil fields producing within their quotas.

Prices Steady

DURING the past month the refinery gasoline quotations in the Mid-Continent district remained steady, while in the east seasonal influences, with early cold weather, resulted in appreciable advances in kerosene, fuel oil and gas oil. Retail motor fuel prices, however, remained upset by general price wars, but slight improvement over last month being noted. Dealers' margins and the problem of differentials between branded and unbranded products continued to be the stumbling block in many efforts and attempts to stabilize the service station prices. As late as on December 7 Socony-Vacuum reduced service station prices 4½ cents per gallon to 12½ cents for regular grade, including all taxes, in Queens

(Continued on page 46)

BABCOCK SPECIAL PROCESS EQUIPMENT



Imperial Chemical Industries Ltd., Billingham.
Group of 3 Exchanging Condensers of Tubular Construction enclosed in cast iron bodies.

The illustrations show some of the special refinery equipment entrusted to "Babcock's" complete facilities for fabrication to clients' designs.

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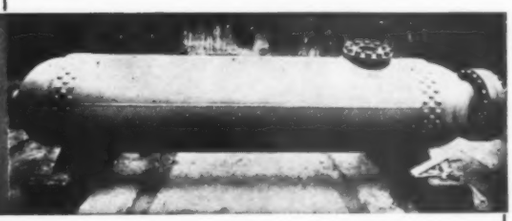
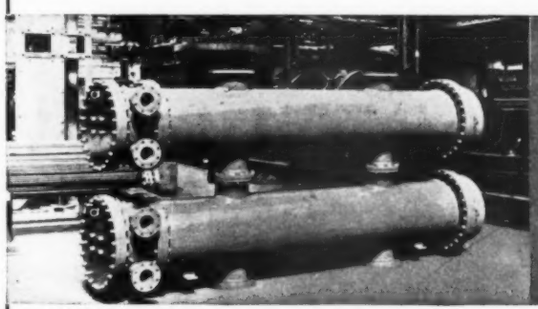
Vacuum Column of Babcock Fusion Welded Construction. 4ft. 0in. diameter x 33ft. 6in. long. Working pressure 110 lbs./sq. in.



Burmah Oil Co.
One of two Gas and Oil Separator Tanks 2ft. 6in. inside diameter x 10ft. 0in. long, Babcock Fusion Welded Construction with riveted heads. Working pressure 1,000 lbs./sq. in.



Stewarts & Lloyds Ltd., Corby.
2 Griscom-Russell Type Floating Head, Removable Tube Bundle Type, Vacuum Condensers, Babcock Fusion Welded Construction. 2ft. 0in. outside diameter x 11ft. 9in. long, weight 6 tons. Working pressure 150 lbs./sq. in.

Foster Wheeler Ltd.
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Effect of Federal Proration Orders in Principal Producing States

	Sept. 1933 to Nov. 1934 Cumulative Overproduction		Nov. 1934 Over-production	Dec. 1934 Federal Daily Quota	Daily Average Production for week ending	
	bbl.	% of Total	bbl.	bbl.	Dec. 1 bbl.	Dec. 8 bbl.
Texas	33,627,000	57.7	1,600,000	941,300	1,012,000	967,500
Oklahoma	10,378,000	17.8	*	451,600	463,500	455,000
California	6,461,000	11.1	430,000	456,800	451,500	492,500
Kansas	1,971,000	3.4	**	123,900	127,500	122,000
United States	58,373,000	100.0	1,710,000	2,307,000	2,420,500	2,406,000

* Oklahoma underproduced 100,000 bbl. during November.
** Kansas underproduced 50,000 bbl. during November.

Borough, New York City; and on the same day Atlantic Refining Company cut its service station price 0.6 cents per gallon to 10.9 cents for regular grade, including all taxes, in Philadelphia, the independents reducing their quotations to 10.4 cents. On December 13 in northern New Jersey, major companies and independents settled the long drawn-out price war, agreeing to a one cent differential between the price of nationally advertised brands and unbranded gasoline. Prices were advanced 5 to 6 cents per gallon with a price of 15.7 cents per gallon including all taxes for major concerns and 14.7 for unbranded gasoline. In St. Louis territory service station prices were advanced 2 cents per gallon by all marketers. An agreement was also reported to have been reached between majors and marketers of unbranded gasoline in the Standard of Indiana marketing territory, indicating a slight general improvement in the marketing branch. On November 26 the Continental Oil Company unsuccessfully attempted to correct marketing evils by establishing in Oklahoma posted tank wagon and service station prices for motor fuel (15.0 and 17.0 cents per gallon respectively), but this constructive move was not followed by other companies.

An interesting experiment will be made early this year, when an oil and gas futures market is to be established on the New York Commodity Exchange and the Chicago Board of Trade, while similar plans are reported from the Pacific Coast. Such trading has been opposed by major companies and the larger independents on the ground that trading in futures is not adaptable to the oil industry, but it appears that a free and open market for petroleum products has distinct advantages for price stabilization, while it will provide hedging facilities for the smaller producers, refiners and jobbers. The proposed standard crude oil trading unit will be 2,000 bbl. of 36 gravity oil, and the standard gasoline trading unit will be 4,200 gallons, 100 bbl., of 56 octane grade; charges are to be made to cover evaporation losses through storage fees.

The crude oil prices remained steady in the principal producing oil fields during the past month. Minor changes included a 19-cent cut by the Panhandle Refining Company in north Texas on November 22, since partially cancelled by an 8-cent advance; and a 25-cent cut in Pennsylvanian fields on December 5 to $2.05 in Bradford-Alleghany district and to $1.67 in Eureka Pipe Line; a similar cut having been made just one month ago on November 6.

Tank wagon/service station motor fuel/ prices per gallon regular grade, including all taxes, in representative districts in the middle of December were: 15.5/16.5 cents in metropolitan New York (14.7/15.7 cents in Newark, N. J.); 15.0/16.0 cents in Boston, Mass.; 13.0/15.0 cents in Providence, R. I.; 14.8/14.8 cents in Chicago; 15.5/17.5 cents in Ohio; 16.5/18.5 and 15.5/17.5 cents in San Francisco and Los Angeles respectively; 15.0/17.0 cents in Oklahoma; 14.7/14.5 cents in St. Louis (14.1/11.0 cents in East St. Louis); and 24.0/27.0 cents in Montreal, Canada; all with a 2-cent differential for premium grade.

Refinery gasoline quotations in the Mid-Continent district remained fairly strong during the past month, though declining about half-a-cent per gallon from the quotations reached around November 15 to 20. Refining gasoline was quoted on December 15 in indifferent market at 3¾–4 cents per gallon for 58–60 U.S.M. Grade 62.9 and below octane rating in Group 3, Oklahoma market; 63.0–70.9 octane rating, U.S.M., brought 4⅝–4⅞ cents per gallon; and 71 and above octane rating, U.S.M. was quoted at 5–5¼ cents per gallon. In East Texas area two sets of prices continued: for shipping in interstate commerce third grade gasoline was quoted 3½ to 3¾ cents per gallon, while shipments within state price dipped to 2½ cents per gallon in the last minute rush of refiners to dispose of their products before the Texas Railroad Commission enforces its tender regulations for intrastate commerce. On the East Coast, at Bayonne, U.S.M. grade 60.0–64.9 octane rating, was quoted unchanged at 5½ cents per gallon (3.25 cents gold*). Gulf Coast prices for export on December 15 were steady at 3⅞ cents per gallon (2.27 cents gold*) for 58–60 U.S.M. grade.

Natural gasoline market was very strong and on December 15 grade 26–70 was quoted at 3¾–4 cents per gallon (2.29 cents gold*) in Oklahoma; at 3½ cents per gallon (2.07 cents gold*) in north Texas; and at 4 cents per gallon (2.35 cents gold*) in North Louisiana.

Kerosene prices firmed slightly during the past month and on December 15 grade 41–43 w.w. was quoted at 3⅜–3⅝ cents per gallon in Group 3, Oklahoma market; and at 5½ cents per gallon (3.25 cents gold*) on the Eastern

* U. S. Dollar at 41 percent discount.

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Coast at Bayonne; Gulf Coast prices for export remained firm at 3⅛ cents per gallon (2.29 cents gold*) for 41–43.

The present outlook for the maintenance of current crude oil posted prices, for the advances in refinery gasolines and for the stabilization of the retail markets continues quite indefinite. The East Texas field remains the weak link in the chain and any breakdown in the present effectiveness of the federal tender board will be followed by the lower prices for crude oil and its derivatives. Current statistical position of the oil industry warrants higher refinery prices even at this time, and their weakness is an indication in itself that the industry is feeling none too easy or too certain about the future. The principal two factors influencing the markets today are: (1) the hearings before the Supreme Court, which is expected to render a mildly favorable decision approving federal production control as such, but probably qualifying it by criticizing past enforcement practices; in any case the Court's decision will be delayed until February; and (2) the prevailing differences in the highly overexpanded and fundamentally unhealthy retail marketing where dealers' margins and differential price between branded and unbranded motor fuels remain unsolved.

Exports Lower

DURING October, 1934, total gross imports of all petroleum products into the United States were maintained at the average rate prevailing during the past twelve months amounting to 3,744,000 bbl., 120,000 bbl. per day, as compared with 3,847,000 bbl., 128,300 bbl. per day, imported during the preceding month. The above figures are for total imports including crude oil shipped in bond for refining and re-export, and fuel oil for supply of vessels in foreign trade. Crude imports in bond are not available at this writing, but 503,000 bbl., 16,230 bbl. per day, of gas oil and fuel oil were imported during October for re-export or for bunkering ships in foreign trade.

Exports of all petroleum products, including motor fuel, in October, 1934, decreased somewhat to 9,234,000 bbl., 298,000 bbl. per day, as compared with 9,851,000 bbl., 328,000 bbl. per day, shipped during September, 1934; and were 12.65 percent below total exports in October of 1933. Exports of crude oil from the United States decreased sharply during October, 1934, to 3,277,000 bbl., as compared with 4,068,000 bbl. exported in the preceding month; and 3,888,000 bbl. shipped during October of 1933. Therefore in October of 1934 crude oil constituted 35.45 percent of the total exports of all petroleum products. The elimination of "hot" oil production in the East Texas field, which in the past found its way into foreign commerce at considerable concessions in prices, has been probably responsible for reduction in export shipping, as was suggested in the preceding issue of WORLD PETROLEUM.

Statistical Position Improved

CRUDE oil and natural gasoline production during November, 1934, averaged about 2,495,000 bbl. per day, 90,000 bbl. per day

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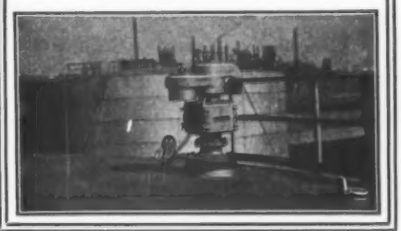
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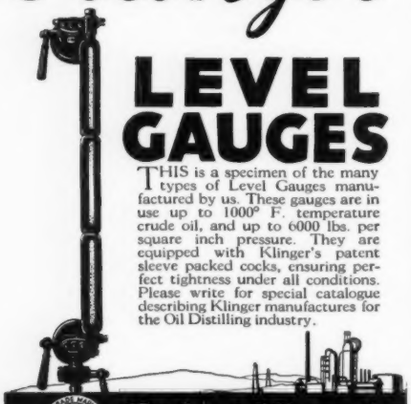

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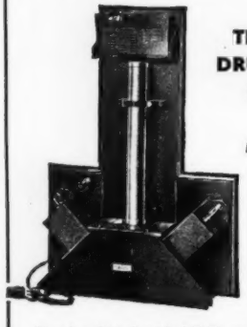

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below the preceding month, and 137,000 bbl. per day below production in September of 1934; it was 151,000 bbl. per day above the crude oil and natural gasoline production in November of 1933. The November, 1934, average crude oil production still exceeded the federal allowable by 57,000 bbl. per day, this figure, however, marking an improvement of 88,200 bbl. per day over the preceding month when 145,200 bbl. were overproduced. Early in December the actual production exceeded the federal allowable for that month by some 100,000 bbl. per day, possibly a temporary jump due to new legislation in Texas and the desire of operators to move most of the "hot" oil out of the East Texas field while such shipments were at all possible. During November the state of Texas accounted for 93.5 percent of national overproduction, while Oklahoma and Kansas both continued under their allowables.

The field activities in the United States assumed boom proportions during October, 1934; 1,234 oil wells were completed in that month, the highest number of completions since July of 1932, when, however, 750 producers were brought in in the East Texas field alone, as compared with but 349 East Texas completions in October, 1934, indicating a much wider activity. Similarly wildcatting showed a sharp increase in activity in the United States, 480 dry holes being completed during October, 1934, or more than at any time since 1930. The acceleration in development is due to smaller initial production in the East Texas field, where currently about 25 percent of all completions are non-flowing, while the results of wildcatting continue mediocre and not sufficient to replace withdrawals.

Total stocks of all oils decreased by a very substantial figure of 7,586,000 bbl. during October, 1934, to a total of 579,581,000 bbl., indicating a daily gross decline in stocks of 244,800 bbl. per day.

The crude oil runs to stills during November, 1934, averaged about 2,470,000 bbl. per day, 38,000 bbl. under October of 1934 when 2,432,000 bbl. were refined per day. The January, 1935, allowable refining activity was increased by the Petroleum Administrator to permit manufacture of 34,750,000 bbl. of gasoline, or 3,990,000 bbl. over the December, 1934, allowance. While the January, 1935, actual gasoline demand was estimated at 29,580,000 bbl. the quota allowed a greater volume to establish sound inventories, which were considered to have declined below the economic minimum. In fact motor fuel stocks, including natural gasolines, dropped 17,723,000 bbl. from March 31, 1934 to October 31, 1934, a remarkable decline of 26.57 percent.

Motor Fuel Demand Above 1931

INDICATED domestic demand for motor fuel during October, 1934, averaged 1,211,000 bbl. per day, an increase of 4.13 percent above the daily average during September, 1934, when 1,163,000 bbl. were consumed; it was 146,000 bbl. per day above the domestic motor fuel consumption in October of 1933, an increase of 13.7 percent; 153,400 bbl. per day above the domestic motor fuel consumption in October

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of 1932, an increase of 14.51 percent; and most important 56,000 bbl. per day above the domestic motor fuel consumption in October of 1931, the peak year, an increase of 4.85 percent. This remarkable showing, anticipated in the preceding issue of WORLD PETROLEUM, can be credited to a very large extent to price "wars" in the most thickly populated areas of the United States, where motor fuel dropped to 9 and 10 cents per gallon, all taxes included, from formerly prevailing quotations of from 18 to 20 cents, and the low prices continued for a period of over two months.

The NEW YORK TIMES weekly combined business index steadily advanced during November gaining 4 points and standing on December 1, 1934, at 79. The index stood at 74 on December 1, 1933; at 69 on December 1, 1932; and at 77.5 on December 1, 1931. The general business conditions showed signs of pick-up as President Roosevelt promised in the future more conservative measures for pulling the country out of depression. Pre-holiday retail trade in consumption goods showed recently a remarkable improvement over the preceding two years, and may be taken as a measure of the change in the mental attitude of the people; which may spread gradually to affect the basic industries. The government is at this time concerned not to let the improvement, if coming, out of hand, and will bend its efforts towards slow and fundamentally sound recovery, rather than repeat the flash of June–July 1933, when the NEW YORK TIMES index climbed from 60 in March, 1933, to 99 in July, only to plunge to 72 by November, 1933.

The daily rate of exports of motor fuel averaged 63,000 bbl. in October, 1934, unchanged from the revised figures for the preceding month; 29.6 percent below the exports in October of 1933; 17.8 percent under the exports in October of 1932; and 43.6 percent under the motor fuel exports in October of 1931.

On November 1, 1934, motor fuel stocks at refineries, plants, terminals and in transit amounted to 49,263,000 bbl., a decline of 3,279,000 bbl. as compared with stocks on hand on October 1, 1934, indicating that during October motor fuel demand exceeded supply by 105,800 bbl. per day.

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